U.S. Army
Corps of
Engineers

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Luckey Site

Luckey, Ohio

Proposed Plan

Prepared for:
U.S. Army Corps of Engineers
Buffalo District

Prepared by:
Science Applications International Corporation
Twinsburg, Ohio

Managed by:
MWH Americas, Inc.

Total Environmental Restoration Contract
DACW27-97-D-0015 Task Order 0009
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Louisville District

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MWH

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SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

UNITED STATES ARMY CORPS OF ENGINEERS
PROPOSED PLAN FOR THE LUCKEY SITE
LUCKEY, OHIO

This Proposed Plan for the remediation of the Luckey site was prepared by the United States Army Corps of Engineers (USACE), under its authority to conduct the Formerly Utilized Sites Remedial Action Program (FUSRAP). On October 13, 1997, the Energy and Water Development Appropriations Act, 1998 was signed into law as Public Law 105-62. Pursuant to this law, FUSRAP was transferred from the Department of Energy (DOE) to the USACE. As a result of this transfer, the responsibility for this project was transferred to USACE. The Energy and Water Development Appropriations Act for Fiscal Year 2000, Public Law 106-60, provides authority to USACE to conduct restoration work on FUSRAP Sites subject to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 United States Code (USC) 9601 et seq., as amended. Therefore, USACE is conducting this project in accordance with CERCLA.

USACE is addressing beryllium, lead, and radiological contamination at the Luckey site associated with the beryllium production efforts performed for the Atomic Energy Commission (AEC) in the early years of the United States' atomic energy program. This Proposed Plan explains USACE's recommendation, the Preferred Alternative, to address soils and groundwater impacted by AEC-related activities and associated constituents of concern (COCs) at the Luckey site and was prepared to fulfill the requirements of CERCLA Section 117(a) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR 300.343(f)(2)].

USACE reviewed the Remedial Investigation Report for the Luckey site, the Feasibility Study for the Luckey site, and other relevant documents, and does hereby propose that the preferred alternative be excavation and off-site disposal of impacted soils (Alternative 5), and Monitored Natural Attenuation with a monitoring program to evaluate effectiveness for groundwater (Alternative 7) as described in this Proposed Plan. After evaluating this remedy pursuant to the criteria described in the NCP, 40 CFR Part 300.430(e)(9)(iii), USACE considers it to be protective of human health and the environment and cost effective.

USACE invites members of the public to review the Proposed Plan and the supporting documents which further describe the conditions at the Luckey site and the basis for this Proposed Plan. These documents may be found in the administrative record files for the Luckey site available at the following locations:

USACE FUSRAP Public Information Center
1776 Niagara Street
Buffalo, NY 14027
(716) 879-4197
(800) 833-6390 [press "5" at the recorded message]

Luckey Public Library
228 Main Street
Luckey, OH 43443
(419) 833-6040

UNITED STATES ARMY CORPS OF ENGINEERS
PROPOSED PLAN FOR THE LUCKEY SITE
LUCKEY, OHIO

Members of the public who wish to comment on this proposed plan may submit their comments in writing to USACE at the following address:

U.S. Army Corps of Engineers, Buffalo District
FUSRAP Public Information Center
1776 Niagara Street
Buffalo, NY 14207-3199

Please refer to this Proposed Plan or to the Luckey site, in any comments. All comments will be reviewed and considered by USACE in making its final decision on remedial actions to be conducted at the Luckey site. Comments should be submitted no later than 30 days after the date of this Proposed Plan.

After the close of the public comment period, USACE will review all public comments, as well as the information contained in the administrative record file for this site, and any new information developed or received during the course of this public comment period, in light of the requirements of CERCLA and the NCP. An authorized official of USACE will then make a final selection of the remedial action to be conducted at this site. This decision will be documented in a Record of Decision, which will be issued to the public, along with a response to all comments submitted regarding this Proposed Plan.

If there are any questions regarding the comment process, or the Proposed Plan, please direct them to the address noted above, or telephone (716) 879-4197 or (800) 833-6390.

/S/

JEFFREY M. HALL
Lieutenant Colonel, U.S. Army
District Engineer

23 May, 2003

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS, ABBREVIATIONS & SYMBOLS

ABD	Acute Beryllium Disease
ACS	American Cancer Society
ADD	average daily dose
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
BBC	Brush Beryllium Company
bgs	below ground surface
BRA	baseline risk assessment
CBD	Chronic Beryllium Disease
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	constituent of concern
COPC	constituent of potential concern
CPEC	constituent of potential ecological concern
DCGL	derived concentration guideline level
DPC	Defense Plant Corporation
DOT	Department of Transportation
EEQ	environmental effects quotient
EMC	elevated measurement comparison
EPA	Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
EU	exposure unit
FR	Federal Register
FS	Feasibility Study
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	Fiscal Year
Gal/min	gallons per minute
GCS	General Sciences Corporation
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic Model
K_d	Distribution Coefficient
IDW	Investigative Derived Waste
ILCR	incremental lifetime cancer risk
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	maximum contaminant level
MED	Manhattan Engineering District
mL/g	Milliliters per gram
mg/kg	milligrams per kilogram
MNA	Monitored Natural Attenuation
mrem/yr	millirem per year
MW	Monitoring Wells
NCP	National Contingency Plan

ACRONYMS, ABBREVIATIONS & SYMBOLS

NPDES	National Pollutant Discharge Elimination System
NPDWR	National Primary Drinking Water Regulation
NRC	Nuclear Regulatory Commission
OAC	Ohio Administrative Code
Ohio DNR	Ohio Department of Natural Resources
ODH	Ohio Department of Health
O&M	Operation and Maintenance
ORNL	Oak Ridge National Laboratory
pCi/g	picocuries per gram
PP	Proposed Plan
PPE	Personal Protective Equipment
ppb	parts per billion
PVC	Polyvinyl Chloride
RA	Remedial Action
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radiation Computer Code
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SESOIL	A Seasonal Soil Compartment Model
SOR	Sum of Ratios
TEDE	Total Effective Dose Equivalent
TRV	toxicity reference value
TRW	Technical Review Workgroup
USACE	United States Army Corps of Engineers
μg/dL	micrograms per deciliter
μg/L	micrograms per liter
μR/h	microrems per hour
USC	United States Code

EXECUTIVE SUMMARY

The Proposed Plan for the Luckey site was prepared by the United States Army Corps of Engineers (USACE), which is implementing the Formerly Utilized Sites Remediation Action Program (FUSRAP), under the authority and procedures of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). USACE is addressing beryllium, lead, and radiological contamination at the Luckey site associated with the beryllium production efforts performed for the Atomic Energy Commission (AEC) in the early years of the United States' atomic energy program. This Proposed Plan explains USACE's preliminary recommendation, the Preferred Alternative, to address soils and groundwater impacted by AEC-related activities and associated constituents of concern (COCs) at the Luckey site. The public is encouraged to review and comment on the selection of this Preferred Alternative. Comments provided by the public will be considered by USACE prior to selection of the final remedy which will be documented in the Record of Decision.

The Luckey site is comprised of a large production building and warehouse, two abandoned railroad spurs, and several smaller process and support buildings. The area surrounding the site to the west, north, and east is primarily residential farmland. From 1949 to the early 1960s, the Brush Beryllium Company, as a contractor to the AEC, used the Luckey site for beryllium processing in support of the national defense program. AEC production activities brought different types of source media or potential contaminant contributors to the site. The source media at the Luckey site included materials delivered for processing or re-processing: beryl ore from Africa and South America; scrap beryllium; and contaminated scrap steel.

USACE identified six AEC-related COCs in impacted soils posing unacceptable risk to human health: beryllium, lead, radium-226, thorium-230, uranium-234, and uranium-238. All six COCs pose unacceptable risks under a subsistence farmer scenario (i.e., a human health receptor who resides on the site and is self-sufficient from food grown or produced on site), which is equivalent to an unrestricted release scenario under Ohio law. USACE also identified three AEC-related COCs in groundwater, which exceeded drinking water standards: beryllium, lead, and total uranium. These groundwater COCs are confined to the upper aquifer located in the unconsolidated sediments or overburden (between ground surface and approximately 20 feet below ground surface).

The preferred alternative for impacted soils is excavation and off-site disposal, and the preferred alternative for groundwater is Monitored Natural Attenuation with a monitoring program to evaluate effectiveness. The estimated total cost to implement both alternatives is $37.3 million. The soil alternative is considered to be the most protective both in the short- and long-term and is permanent because all soils exceeding the unrestricted land use cleanup goals will be removed from the Luckey site. The transport and disposal volume of soil exceeding unrestricted land use cleanup goals is estimated at 88,000 cubic yards. This complete removal also precludes further potential for contamination of the groundwater system. Implementation of both the soil and groundwater alternatives together will allow release of the site for unrestricted use in a reasonable period of time. Release of the Luckey site would only be with respect to the AEC-related materials associated with the beryllium production process.

In this Proposed Plan, USACE has identified remedial alternatives and suggests a Preferred Alternative to address AEC-related COCs. USACE will select a final remedy to be documented in the ROD for the site after reviewing and considering all information submitted during a 30-day comment period. Therefore, USACE encourages the public to review and comment on all the alternatives presented in this Proposed Plan.

Further evaluations and explanations associated with the contents of this Proposed Plan are contained in the Remedial Investigation report and the Feasibility Study report. These and other documents regarding the Luckey site comprise the administrative record file at the Public Information center at the Buffalo District USACE Office and at the Luckey Public Library.

Comments on the proposed remedial action at the Luckey site will be accepted for 30 days following issuance of the Proposed Plan in accordance with CERCLA. A public meeting will be conducted during the comment period to receive verbal comments from the public. Written comments the public wishes to submit regarding the Preferred Alternative will be received at this meeting and during the 30-day period. Responses to the public comments will be presented in the Record of Decision, which will document the final remedy selected for the Luckey site.

All written comments should be addressed to:

U.S. Army Corps of Engineers, Buffalo District
FUSRAP Public Information Center
1776 Niagara Street
Buffalo, NY 14207-3199

1.0 INTRODUCTION

This Proposed Plan (PP) for the Luckey site was prepared by the United States Army Corps of Engineers (USACE) under its authority to conduct the Formerly Utilized Sites Remediation Action Program (FUSRAP). USACE is issuing this PP as part of its public participation responsibilities under the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 42 United States Code (USC) 9617(a) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40 CFR § 300.430(f) (2). This plan addresses only the constituents associated with the beryllium production efforts performed for the Atomic Energy Commission (AEC), which consists primarily of beryllium, materials associated with the beryllium production process, and radioactive residuals at this site in Luckey, Ohio. This document presents USACE's preliminary recommendation, the Preferred Alternative and supporting rationale, for addressing contamination at the Luckey site.

Two key documents associated with this PP are the Remedial Investigation (RI) report (USACE 2000), which describes the nature and extent of contaminants; and the Feasibility Study (FS) (USACE 2003), which describes the development and evaluation of the remedial alternatives presented in this PP. Information also is taken from the Baseline Risk Assessment (BRA), contained in the RI and the FS Reports, which assesses risks to public health and the environment posed by contaminants in the environmental media at the site.

The RI, the FS, and other documents regarding the Luckey site are contained in the administrative record file at the Public Information Center at the Buffalo District USACE Office and at the Luckey Public Library. USACE encourages the public to review all available material about the Luckey site in order to gain a more comprehensive understanding of the activities that have been conducted there.

There were two units evaluated during the RI and the FS that USACE is addressing in this Proposed Plan:

- Impacted Soils (on-site and off-site contiguous soils)
- Site-wide Groundwater

On-site soils are those located within the current fenced boundaries of the site. Off-site soils are located on the land adjacent to the facility, which is used for residential and agricultural purposes, and also includes the former railroad bed.

USACE evaluated a number of alternatives for remediating impacted soils and groundwater. USACE has determined the preferred alternative for impacted soils is excavation and off-site disposal, and the preferred alternative for groundwater is Monitored Natural Attenuation (MNA) with a Performance Monitoring Program to evaluate effectiveness. These alternatives are protective of human health and reduce risks to ecological receptors due to removal of contaminated soils from the site. The technology for these alternatives are relatively easy to implement and readily available. The remedial action for soil would require approximately three (2.9) years to complete. The groundwater remedial action would potentially require a 40- to 150-year operation and maintenance (O&M) period after impacted soils have been addressed.

There were several additional units evaluated during the RI and the FS that USACE is not addressing in this Proposed Plan:

- Toussaint Creek (including on-site and off-site drainage ditches)
- France Stone Quarry
- Troy Township Dump (landfill)
- On-site buildings

Toussaint Creek includes both the on-site and off-site drainage ditches. As discussed in the FS (USACE 2003), there were no unacceptable risks to human health or the environment due to AEC-related constituents for Toussaint Creek. Based on these results and discussions presented in the FS, this unit requires no further action and will not be discussed further in this PP.

The France Stone Quarry and Troy Township Dump are located just south of the Luckey site. As discussed in the RI (USACE 2000), analytical results do not indicate any unacceptable impacts at either location as a result of AEC-related activities at the Luckey site. Consequently these units require no further action and will not be discussed further in this PP.

After evaluating the results of the RI for the on-site buildings, USACE has concluded there is no evidence of a release from the buildings, as defined by CERCLA, nor evidence of a substantial threat of a release of hazardous substances into the environment from the buildings. CERCLA defines the term "release" to mean "any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment", and specifically excludes "… any release which results in exposure to persons solely within a workplace, …". Therefore, the buildings would not qualify to be addressed under CERCLA and are no longer within the scope of the CERCLA efforts being undertaken by USACE at the Luckey site.

The final remedy decision will be documented in the Record of Decision (ROD). USACE may modify the preferred alternative or select another alternative presented in this PP based on new information or public and/or regulatory agency comments. Thus, the public is encouraged to review and comment on all of the alternatives identified herein.

2.0 SITE BACKGROUND

From 1949 to the early 1960s, the Brush Beryllium Company (BBC), as a contractor to the AEC, used the Luckey site for beryllium processing in support of the national defense program. These processing activities resulted in the occurrence of elevated levels of beryllium, lead, and radionuclides in portions of the property. The Luckey site was designated as eligible for inclusion in FUSRAP in 1991. FUSRAP was established to remediate sites impacted by activities of the Manhattan Engineering District (MED), or the AEC in the early years of the nation's atomic energy program. The scope of the remedial action at the Luckey site is to address beryllium, materials associated with the beryllium production process including lead, and radioactive residuals.

Currently, the facility is owned by Hayes Lemmerz International, Inc. Approximately 23 acres of the site is leased to Uretech International, Inc. Uretech uses the facility to manufacture urethane parts for the automotive, sporting goods, and health care industries.

2.1 ENVIRONMENTAL SETTING

The Luckey site is located at 21200 Luckey Road in Luckey, Ohio. The village of Luckey, Ohio is located 22 miles southeast of Toledo (Figure 2.1) with a population of approximately 1,500 people. The property is approximately 40 acres in size near the corner of Gilbert and Luckey Roads in Wood County. Just south of the Luckey site is the France Stone Quarry and the Troy Township Dump. The quarry has an estimated total depth of 70 feet and has been inactive since the 1970s. Figure 2.2 displays an aerial view of the site.

The area is rural in character. Local land use is predominantly agricultural, producing crops such as corn, soybeans, and winter wheat with farm fields to the north, east, and west of the site. Patches of forests and old fields of varying ages are present throughout the area.

The topography of the area is generally flat with shallow surface gradients sloping slightly towards Lake Erie. The Luckey site is generally higher in the northeast corner due to past disposal activities. Toussaint Creek is approximately 634 feet above mean sea level (amsl) where it passes beneath Lemoyne Road.

As shown in Figure 2.3, the Luckey site consists of a large production building and warehouse, two abandoned railroad spurs, and several smaller process and ancillary buildings. Uretech uses the two largest buildings on site, the Production Building and the Annex. The remainder of these buildings are used for administrative activities and storage.

The northeastern corner of the site was used as a disposal area for lagoon sludges, scrap metal, and other waste materials (Figure 2.3). It is possible that this area also was used as a landfill and may contain a variety of disposed materials. Spoils piles located in this area consist of excavated soil, process materials, building rubble, and ores.

The site also has three former process waste lagoons, designated Lagoons A, B, and C, located in the southeastern corner of the site. In 1949, Ohio Department of Health (ODH) approved the use of these lagoons to dispose waste process sludges. No monitoring records have been found. Lagoons A and B were apparently used simultaneously and probably contained various waste sludge generated at different stages of beryllium processing activities. Lagoon C likely received waste similar to that in Lagoons A and B. A fourth lagoon, Lagoon D, was excavated northeast of Lagoons A, B, and C but was never used.

Surface drainage features at the Luckey site include several outfalls (permitted under the National Pollutant Discharge Elimination System [NPDES]), storm sewers, drainage ditches, and wetland areas. Two primary channels convey on-site discharge sources: the main drainage ditch and the western drainage ditch. Toussaint Creek is approximately 0.2 miles north of the Luckey property and eventually empties into Lake Erie approximately 25 miles downstream. The main drainage ditch discharges directly into Toussaint Creek. The western drainage ditch runs along Luckey Road, also eventually draining into Toussaint Creek. There also is a shallow emergent wetland approximately 1.6 acres in size north of Lagoon C. During beryllium production operations, when periods of high rainfall or stream flow occurred, Lagoons B and C discharged to the main drainage ditch. Lagoon A drained into the western drainage ditch along Luckey Road. The BBC reported these events to the ODH, who allowed these releases during high flow.

2.2 SITE HISTORY

In 1942, the Defense Plant Corporation (DPC) built a magnesium reduction plant at the Luckey site to produce metallic magnesium. The production of metallic magnesium created residual iron, silicon, and calcium. The government disposed of the residue in a quarry operated by Kelly Island Stone and Limestone (Kelly Island and DPC 1943). In November 1945, the magnesium reduction plant was closed as a war surplus plant.

The Luckey facility was transferred to the Reconstructed Finance Corporation in 1945. As early as 1946, BBC, as a contractor to the AEC, was allowed to use equipment from the Luckey plant in pilot projects. BBC leased the entire site in 1949 and contracted with the AEC. BBC designed, constructed, operated, and maintained the Luckey plant for the production of beryllium. The plant produced mostly beryllium hydroxide (Powers 1983), in addition to some beryllium metal in vacuum-cast billets and beryllium oxide (from beryllium hydroxide). Employee interviews indicate beryllium waste was not disposed off site during beryllium operations (Cline 1990). BBC transferred beryllium production operations to a new facility located in Elmore, Ohio in 1958. Sintering and powder blending operations, established at the Lucky facility in 1957, continued through the early 1960s, then were shut down.

The sources of contamination at the Luckey site include raw materials brought to the site for processing and by-products generated during site operations. According to employee interviews, beryl ore purchased from brokers or the AEC was delivered to the site in bags and drums. The ore was stored on both sides of the railroad siding near the railroad scales and on runways adjacent to the production buildings. Lead oxide was an additive in the beryllium production process.

Ground beryl ore was obtained from the former Middlesex Sampling Plant in Middlesex, New Jersey (another AEC facility). The rock grinders that crushed the beryl ore also were used to grind uranium ores. The beryl ore may have acquired radiological constituents left behind by the uranium grinding operations. Pegmatites containing beryl ore obtained from South America also may have contained small amounts of naturally occurring radionuclides (USACE 2000).

Also, there are records indicating the Luckey site received approximately 1,000 tons of scrap steel from Lake Ontario Storage Area in late 1951. The scrap steel was reported to contain radioactive materials such as radium-226, thorium-230, uranium-234, and uranium-238. It was stored in the yard north of the main building along the railroad tracks. Records also indicate beryllium scrap from other AEC operations was being sent to Luckey for reprocessing. Indications are that some of this scrap was contaminated with radionuclides (Smith 1950).

2.3 PREVIOUS INVESTIGATIONS

Prior to the RI/FS, several other investigations were performed at the Luckey site. A summary is provided below and more detailed information can be found in the RI Report (USACE 2000).

Connectivity of the lagoons with groundwater was tested in shallow drilled wells in December 1953. The wells were drilled to 20 feet. Most of the wells were dry, except for one drilled in the southeast corner of the "solar evaporation lagoon," which is assumed to be Lagoon C. The sulfate and beryllium results indicated some connectivity between lagoons and the groundwater, but the absence of water in most wells indicate little percolation was occurring.

A series of water analyses for the potable water supply at the Luckey facility exist for the period from 1985 until 1990. These results show the beryllium in the potable water supply at the Luckey facility has generally been below detectable concentrations and/or below the Safe Drinking Water Act (SDWA) maximum contaminant level (MCL). An exception was in late 1985 and early 1986 where beryllium was detected at concentrations up to 8.8 micrograms per liter (μg/L).

In 1988, the Oak Ridge National Laboratory (ORNL) conducted a preliminary radiological survey of the site. This study involved gamma walkover surveys over a large portion of the property, as well as the collection of surface and subsurface soil and water samples. Gamma exposure rates over the majority of the property ranged from 5 to 9 microrems per hour (μR/h). The radioactivity was elevated in the lagoons and landfill areas. Lagoons A, B, and C had elevated beryllium concentrations with Lagoon B beryllium concentrations as high as 6,400 milligrams per kilograms (mg/kg).

In January 2001, groundwater samples were collected from residential wells located in the vicinity of the Luckey site. Sampling activities were sponsored by USACE in conjunction with the Wood County Health Department. Groundwater samples were analyzed for beryllium, manganese, and total uranium. Beryllium was not detected in any of the groundwater samples. Neither manganese nor total uranium were detected above drinking water standards (50 μg/L and 30 μg/L, respectively). Manganese was detected at concentrations ranging from 0.54 to 31.2 μg/L. Total uranium was detected at concentrations ranging from 0.02 to 14.0 μg/L. Average concentrations were 6.1 μg/L for manganese and 3.39 μg/L for total uranium.

3.0 SITE CHARACTERIZATION

3.1 GEOLOGY AND HYDROGEOLOGY

The uppermost bedrock in the region consists of carbonate bedrock, the Lockport Dolomite, which is approximately 300 feet thick in the Luckey area. Unconsolidated overburden consisting of glacial sediments and soils overlay the bedrock and range in thickness from 15 to 26½ feet. The glacial sediment contains clay and silt with a thin, discontinuous layer of sand and gravel near the bedrock. The soils are derived from the weathering of the glacial sediments and consist of clay and clay loam, which results in poor drainage.

There are two groundwater sources present in the vicinity of the Luckey site, one in the unconsolidated material above the bedrock surface and the other in the bedrock. The groundwater above the bedrock surface is not typically used as a water supply because of the high clay and silt content and low yield. The bedrock contains a regional aquifer used as a primary source of groundwater by the rural population. This glacial sediment forms a confining layer above the carbonate bedrock aquifer, however, it is not impermeable. As a result, the carbonate aquifer is semi-confined.

The France Stone Quarry south of the Luckey site appears to act as a local source of groundwater recharge to the carbonate bedrock aquifer. Groundwater in the carbonate aquifer flows from the quarry northward toward the Luckey property and Lake Eire. Residents in Luckey generally depend on wells drilled into the carbonate aquifer. Domestic supply wells are typically completed 50 to 80 feet into the carbonate aquifer and cased to the top of the bedrock, approximately 30 feet below ground surface (bgs). A conceptual model depicting the location of the supply wells and groundwater is provided in Figure 3.1.

3.2 CONSTITUENTS OF CONCERN

The RI/FS identified site features, assessed the nature and extent of constituents, evaluated risks to human health and the environment, and developed remedial alternatives to address constituents associated with beryllium production activities at the Luckey site. This PP discusses constituents of concern (COCs) associated with AEC-related activities.

USACE has identified six AEC-related COCs posing unacceptable risks to human health at the Luckey site: beryllium, lead, radium-226, thorium-230, uranium-234, and uranium-238. Hereafter, references to COCs in this document will pertain to these six AEC-related constituents. A conceptual site model of release and transport of these COCs is depicted in Figure 3.2.

Beryllium is a silver-gray metallic element that occurs naturally in soils. Exposure to beryllium can cause many types of health problems. Short-term exposures when inhaling large concentrations of beryllium can lead to inflammation of the lungs. Long-term exposure to beryllium can result in considerably more damage to human health, such as Acute Beryllium Disease (ABD) and Chronic Beryllium Disease (CBD). Both diseases affect many of the body's organs such as the lymph nodes, skin, spleen, liver, kidneys, and heart. Both ABD and CBD can be fatal and primarily affect the lungs, causing shortness of breath, cough, fatigue, and even cancer. Symptoms of CBD may not develop for 30 years or more after the first exposure to beryllium. ABD is caused by breathing in relatively high concentrations of beryllium in dust and fumes. ABD usually occurs within months of exposure and resembles pneumonia or bronchitis. Symptoms of ABD usually disappear when the individual is no longer exposed to beryllium. CBD occurs much more slowly and is most common in individuals who have been exposed to beryllium for a significant period of time (i.e., over months or years). CBD is caused by an allergic reaction in an individual who has become sensitive to beryllium. Sensitized individuals have an inflammatory response when exposed to small amounts of beryllium. Early symptoms of CBD include coughing, fatigue, shortness of breath, and fever. Approximately one to six percent of exposed individuals eventually develop CBD.

Lead's affect on human health is well documented. It is a naturally occurring element that can bind to soil and sediment. Short-term exposure to lead can interfere with red blood cell chemistry, physical and mental development of young children, and cause abdominal pain, vomiting, diarrhea, convulsions, coma and even death. Long-term exposures to lead can cause strokes, kidney disease, and cancer. High dosages of lead can cause paralysis, brain damage, and death.

Radium is a naturally occurring element, which presents a radiological health concern. It exists naturally in small concentrations in soil, rocks, surface water, groundwater, plants and animals. Radium is taken into the human body by ingestion and/or inhalation. Although much of the radium is excreted from the body, some of it may remain in the bloodstream or lungs and be carried throughout the body. Radium also is a source of radon gas, which presents an additional radiological hazard. Exposure to radon is known to cause bone and lung cancer.

Thorium also is a naturally occurring element which presents a radiological health concern. Thorium naturally occurs in soil, rocks, surface water, groundwater, and plants. Thorium can be ingested or inhaled and causes cancers. Lung, pancreatic, and hematopoietic cancers occur through inhalation. Thorium also is known to attach to the skeletal system and cause bone cancer.

Uranium is a naturally occurring element which presents both a toxic and radiological health concern. Uranium is found naturally throughout the world in soils, geologic formations, water, animals and even some natural foods. The element consists primarily of three isotopes: uranium-234, uranium-235, and uranium-238 at approximately 0.006%, 0.7%, and 99.3% by weight, respectively. It is one of the more mobile radioactive elements and can percolate through the soil into groundwater. As with the other COCs, uranium can be ingested or inhaled. The most prevalent human health concerns of uranium exposure occur through ingestion and can lead to bone cancer and kidney damage.

3.3 IMPACTED SOILS

On-site soils were investigated, focusing on features known or believed to have been impacted by past AEC-related activities at the site (Figure 2.3). Brief summaries of these features are provided below. More detailed information is available in the FS Section 2.3 (USACE 2003).

The total in situ volume of soil exceeding unrestricted land use cleanup goals is estimated at 55,400 cubic yards. This represents the in situ volume and does not include any additional volume that may occur during excavation or expansion typically associated with soil removal. Such factors, however, are taken into account for cost estimating purposes. Figure 3.3 presents the extent of impacted soils to be excavated for unrestricted land use.

Trenches and Pits (disposal areas): At least four disposal trenches and pits are located in the northeast corner of the site. Two or perhaps three additional disposal trenches were dug west and south of the disposal area. These trenches and pits were used for the disposal of lagoon sludges, scrap metal, and other waste materials. Inorganic beryllium and lead, and radionuclides radium-226, thorium-230, uranium-234, and uranium-238 were the COCs most commonly detected above background in soil samples collected from the disposal trenches and pits.

Lagoons: Four waste lagoons were constructed in the southeast portion of the Luckey site. Lagoon A received waste from the conversion of beryllium hydroxide to beryllium metal. Lagoon B and

C received discharges from the conversion of beryl ore to beryllium hydroxide through a sulfate process. Lagoon D does not appear to have been used. Inorganic beryllium and lead, and the radionuclides radium-226, uranium-234, and uranium-238 were the most commonly detected COCs above background in soil samples from the lagoons. Lead was not detected above background at Lagoon A. Radionuclides at Lagoon B appear to be primarily associated with soils.

Areas Devoid of Vegetation and Stressed Vegetation Areas: Areas either lacking vegetation or displaying stressed vegetation are located in the north-central portion of the facility near the propane tanks and in the northeastern section of the site near the trenches. The soils in these areas had a number of constituents detected above background, including beryllium, lead, and uranium-234. A weight-of-evidence analysis compared surface soil concentrations of constituents to field observations of stressed vegetation. Elevated concentrations of beryllium and lead were found to be associated with areas devoid of vegetation. Past practices also may have affected the soil structure in these areas and some areas exhibit unusual accumulations of coarse material.

Filter Bed Area and Debris Piles: At the filter bed area and debris piles, beryllium and lead most commonly exceeded background. Radionuclides radium-226, thorium-230, uranium-234, and uranium-238 also were detected above background.

Existing Buildings and Associated Areas: Around the existing buildings, beryllium and lead most commonly exceeded background. Several radionuclides were detected in the soils at low activities or activities slightly exceeding background.

Contiguous Soils: The northern farm field and the abandoned railroad bed showed elevated concentrations of beryllium and lead. The main drainage ditch flows through the northern farm field toward Toussaint Creek. The northern farm field was most likely impacted by contaminants dredged from and placed in the field alongside the ditch. The soils at the northern property boundary also may have received contaminants from windblown deposits or storm water runoff from the Luckey site. Beryllium and radionuclides were detected in soils just east of the site in the vicinity of the abandoned railroad bed. Contaminants may have been deposited there by wind blowing across the bare areas from the disposal trenches or from storm water runoff that collected in the low-lying area.

3.4 IMPACTED GROUNDWATER

Thirty eight monitoring wells (MW) have been installed at the Luckey site and in the farm field north of the site. Monitoring wells were completed either as shallow (S) (in the unconsolidated overburden overlying bedrock), intermediate (I) (within the top 10 ft of bedrock), or deep (B) (greater than 20 ft beneath the top of bedrock). Samples collected from these wells do not indicate a specific plume of contaminated groundwater. Beryllium has been detected above the drinking water standard (4 μg/L) in five monitoring wells and in the West Production Well with a maximum detected value of 137 μg/L. Lead was detected above the drinking water standard action level (15 μg/L) in three wells with a maximum detected value of 47.9 μg/L. Uranium was consistently detected above the drinking water standard (30 μg/L) in one well with a maximum detected concentration of 390 μg/L. Figure 3.4 depicts the locations where beryllium, lead, and uranium have been detected in groundwater above cleanup goals.

Groundwater COCs are confined to the upper aquifer located in the unconsolidated sediments. Groundwater in bedrock at depth does not appear to have been impacted. Because COCs are only found in a few on-site monitoring wells, with no indication of a plume, the volume of groundwater exceeding cleanup goals has not been estimated. Instead, groundwater transport scenarios were simulated for each alternative to evaluate both the effectiveness and the timeframe to achieve cleanup goals in groundwater.

4.0 SCOPE AND ROLE OF THE RESPONSE ACTION

This response action will address impacted soils and groundwater at the Luckey site. Under FUSRAP, USACE is authorized to remediate only those COCs originating from AEC-related activities. At the Luckey site, these COCs include beryllium, materials associated with the beryllium production process, and radioactive residuals. Constituents not associated with AEC activities may be remediated only if mixed with AEC-related COCs. If these constituents are co-mingled with AEC-related COCs, they will be remediated and addressed in terms of proper disposal and other actions. The scope of this response action addresses the following constituents: beryllium, lead, radium-226, thorium-230, and uranium in soils and groundwater.

Current land use at the Luckey site is industrial and is expected to remain industrial for the near future. The property is currently zoned light industrial. Wood County has a comprehensive plan (Wood County 1998) for Troy Township that acts as a guide for zoning and future use. It states that the property is an expansion area for the Village of Luckey, indicating that the village is slated to grow into the area. Given the current zoning designation, the most likely future expansion use for the property is industrial or commercial use. However, it is possible that the future use could be residential or agricultural for several reasons. Surrounding land use on three sides of the Luckey site is agricultural and residential. Agricultural and residential are the dominant land uses throughout Troy Township. There is no other industry in the immediate area and industrial facilities at the site are aging. The most recent deed to the property (a quitclaim deed from Goodyear on April 1, 1987) lists no specific restrictions or easements that would preclude residential or agricultural land use.

5.0 SUMMARY OF SITE RISKS

The BRA (USACE 2000, USACE 2003) provides a quantitative estimate of potential risks to human health and the environment from chemical and radiological constituents at the Luckey site. In accordance with United States Environmental Protection Agency (EPA) guidance, the primary health risks investigated were cancer and other chemical-related illnesses (non-cancer), as well as risks to ecological receptors. The purpose of the risk assessment was to determine the need for cleanup and provide a baseline to compare remedial alternatives. The complete risk assessment is contained in the administrative record file. A brief summary of the radiological and chemical health risks, as well as the ecological risks is provided herein. In the FS, potential risks to an additional receptor, the subsistence farmer, were evaluated as a supplement to the BRA. This subsistence farmer receptor is a more conservative assessment of site risks than any other scenario evaluated in the BRA for human receptors.

The objectives of the Luckey site risk assessment were to:

- Identify areas that do not pose unacceptable risks to human health or the environment, and thus require no further action.
- Develop a list of COCs for each exposure unit, which contribute to unacceptable risks to human health or the environment.
- Estimate potential risks to human health and the environment associated with the Luckey site if no remedial action occurs, assuming no controls (e.g., fencing, maintenance, protective clothing, etc.) are, or will be, in place.
- Develop risk-based concentrations (RBCs) and radionuclide action levels for the identified COCs to provide the basis for preliminary media-specific cleanup goals, in order to focus remedy selection on constituents that are the significant contributors to potential risk.

The risk assessment performed an exposure assessment to identify current and future populations that may reasonably be anticipated to be exposed to constituents of potential concern (COPCs). For purposes of the BRA, the Luckey site was divided into exposure units (EUs). The results of the BRA, combined with an evaluation of applicable or relevant and appropriate requirements (ARARs), were used to identify preliminary COCs at each EU. Impacted soils and groundwater encompass the following EUs evaluated in the BRA:

- EU 1: On-site undisturbed soil within the current fenced boundaries of the site
- EU 2: On-site disturbed soil within the current fenced boundaries of the site
- EU 3: Off-site land surrounding the facility currently used for residential/agricultural purposes including the former railroad bed (contiguous with site)
- EU 7: Groundwater (on-site and off-site).

For EU 2, the term “disturbed soil” refers to the eastern portion of the Luckey site where historic operational and disposal activities occurred (e.g., the lagoons and disposal in excavated trenches). “Undisturbed soil” refers to the remainder of the property (i.e., EU 1).

Environmental media that may transport contaminants to receptors were identified (e.g., soil), as well as the route of uptake in the receptor (e.g., ingestion, inhalation, or absorption). The concentration of each COPC that the receptor was potentially exposed to was estimated. This is known as the exposure point concentration (EPC). The toxicity of the various COPCs was estimated using the latest data from state, federal, and other appropriate sources such as the National Center for Environmental Assessment and the Agency for Toxic Substances and Disease Registry. The EPC, exposure assessment, and toxicity data all utilize conservative assumptions that build in additional safety factors for the public.

A summary of the BRA and the process for determining COCs, including comparisons to ARARs, are discussed in more detail below. Table 5.1 lists the COCs identified in the human health risk assessment (HHRA) or based on the presence of the COCs in groundwater above chemical specific criteria established by ARARs.

5.1 HUMAN HEALTH RISK ASSESSMENT

5.1.1 Definitions

The BRA identified the means by which people and the environment may be exposed to preliminary COCs present at the Luckey site. When ARARs are not available or not sufficiently protective because of the presence of multiple pathways of exposure, risk-based concentrations are developed. Human health risks were evaluated against risk-based goals established by CERCLA (EPA 1989a,b). In this evaluation, USACE considered two types of risk: non-cancer risk and cancer risk.

For non-cancer health effects, the RBC uses a "total hazard index," (HI). To find the HI, the potential for chemical non-carcinogenic health effects is expressed as chemical-specific hazard quotients (HQs). HQs are tabulated for all preliminary COCs and summed for each pathway to provide an HI for the pathway. For non-carcinogens, acceptable exposure levels are concentrations that do not exceed an HI of 1.

For cancer risks, "the risk-based acceptable range established by CERCLA exposure levels is generally concentration levels that represent an excess upper bound life-time cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response." Mathematical models were used to predict possible incremental increases to risk on human health and the environment from exposure to elevated levels of radionuclides and chemicals for both present and future uses at the site. An incremental lifetime cancer risk (ILCR) of 10^{-6} corresponds to the conservative end of the acceptable risk range (EPA 1990).

The likelihood of any kind of cancer resulting from a Superfund site is generally expressed as an upper bound probability. Therefore, the real risk is expected to be less. The 10^{-6} risk level does not equate to an actual cancer incidence of one in a million. For substances that may cause cancer, the risk assessment process uses animal data to predict the probability of humans developing cancer over a 70-year lifetime. In other words, for every one person out of one million people that could be exposed, one extra cancer *may* occur as a result of exposure to site contaminants. On an individual scale men have a one in two chance, while women have a one in three chance of developing cancer over their life time [American Cancer Society (ACS) 2002]. The incremental rise to this background cancer risk for an individual would be increased by one millionth based on exposure to a site that has a risk characterization of one-in-a million.

In the context of human health risks, 10^{-5} is a shorthand description for an increased lifetime chance of one in 100,000 of developing cancer due to lifetime exposure to a substance. The carcinogenic cancer threshold of 10^{-5} falls within the acceptable risk range of 10^{-4} to 10^{-6} specified by the National Contingency Plan (NCP) (EPA 1990). The risk level 10^{-5} is less than the current risk of developing cancer from background exposure to environmental contaminants estimated at 10^{-3} to 10^{-2} (Kelly and Cardon 1991). Personal lifestyle decisions such as smoking, high fat diets, and exposure to sunlight contribute to cancer risk. In addition, certain inherited genes can predispose some individuals to a very high risk of developing specific cancers. In the U.S., men have a little less than 1 in 2 ($5x10^{-1}$) lifetime risk of developing cancer from all sources, and for women the risk is a little more than 1 in 3 ($3x10^{-1}$) (ACS 2002).

In 1991 EPA issued a memorandum to clarify the Role of the BRA in Superfund Remedy Selection Decisions (EPA 1991). This Office of Solid Waste and Emergency Response Directive states that where cumulative carcinogenic site risk to an individual based on reasonable maximum exposure is less than 10^{-4}, and the non-carcinogenic HI is less than 1, action is generally not warranted unless the potential for adverse environmental impacts exists. Therefore, the use of target risk levels of total pathway cancer risks not to exceed 10^{-4} (and individual constituent risks not to exceed 10^{-5}) or a non-cancer risk threshold of an HI not to exceed 1 are believed to be protective of human health.

5.1.2 HHRA at the Luckey Site

The HHRA evaluated risks to several current and future receptor populations. For current land use, these receptors included industrial workers (on-site), resident farmers (off-site), and adolescent trespassers (off-site). For future land use, these receptors included those identified as current receptors and resident farmers (on-site) and subsistence farmers (on-site). The subsistence farmer scenario is not contained in the BRA (USACE 2000). Subsequent meetings between site planners and stakeholders resulted in the introduction of this additional, more conservative receptor based on the requirements of 10 Code of Federal Regulations (CFR) Part 20 Subpart E and Ohio Administrative Code (OAC) 3701:1-38-22, to evaluate the "critical group" for radionuclides. For unrestricted release, the State of Ohio has consistently defined the subsistence farmer as the critical group. Risk calculations and revised cleanup goals resulting from the evaluation of the subsistence farmer scenario are presented in Appendix 3A of the FS (USACE 2003). Although not required by either 10 CFR Part 20 Subpart E or OAC 3701:1-38-22, chemical constituents also were evaluated using the subsistence farmer scenario. Both the subsistence farmer and residential farmer may be exposed to site contaminants in soil, groundwater, surface water, and sediment. The subsistence farmer is more conservative than the residential farmer because this scenario also includes the consumption of food grown or produced on site. In addition to unrestricted land use, the current/future industrial use of the site (e.g., restricted land use) was evaluated.

The risk assessment procedures follow EPA's *Risk Assessment Guidance for Superfund* (RAGS) (EPA 1992). The EPA guidance requires that the modeling also include what is called a Reasonable Maximum Exposure (RME) scenario. These calculations assume an individual would be exposed to the constituents on the properties for prolonged periods of time. Lead was evaluated using EPA's Integrated Exposure Uptake Biokinetic Model (IEUBK) for Lead in Children (EPA 2001). For current and future land uses, the residual radioactivity model software, Residual Radiation Computer Code (RESRAD) (Version 6.1) was used for radiological contaminants in soil (Yu 1993).

Chemical and radiological constituents are identified as preliminary COCs if they contribute significantly to total risk (i.e., the concentration or activity must be reduced in order to reduce total ILCR below target levels). All exposure pathways evaluated in the BRA are considered in the FS, which include ingestion, dermal contact, external gamma, inhalation of fugitive dust and volatiles, in addition to food intake pathways for the subsistence farmer. However, risks were evaluated separately for non-radiological and radiological constituents because the cancer slope factors used to quantify cancer potential were developed differently for the two classes of compounds (USACE 1999).

For non-cancer risk, constituents that contribute an HI of 1 or greater (individually or in combination with other constituents) for a particular target organ are considered preliminary COCs. Results indicate beryllium in soil exceeded the HI limit with a value of 5.8 for the future land use including subsistence farming for EU 2, and lead exceeded the risk-based standards for both the subsistence farmer and the industrial worker.

For cancer risks, the BRA selected preliminary COCs based on a cancer risk limit of 10^{-6} per pathway, where total risk per exposure unit was greater than 10^{-5}. These target risk limits were used in identifying preliminary COCs in the BRA, as per guidance from Ohio EPA. In the FS, a risk management decision was made to consider COCs that contributed the most to risk. For cancer risk, constituents that contribute greater than 10^{-5} ILCR for any receptor (within an exposure unit where cumulative cancer risks are greater than 10^{-4}) are considered significant and therefore are the COCs addressed in this PP.

For cancer risks, the total pathway (inclusive of soil, groundwater, surface water, sediment consumption of food and produce) to the receptor is first identified when the total risk is greater than 10^{-4}. The COCs are then defined as any individual constituents having a total risk (across all pathways) greater than 10^{-5}. Results indicate total risks for radionuclides exceed the 10^{-4} threshold for the subsistence farmer in all soil exposure units. The risk estimates for cancer risks in soils 0 to 2 feet and 0 to 10 feet are provided for the subsistence farmer in Table 5.2 and the industrial worker in Table 5.3. For the subsistence farmer, COCs identified in soils include beryllium, lead, radium-226, thorium-230, uranium-234, and uranium-238. Only lead in soils was identified as posing unacceptable risk to the industrial worker.

Non-cancerous effects are the primary concern for exposures to beryllium and lead. The BRA determined that child receptors were susceptible to these effects at lower concentrations than adults. The subsistence farming future land use scenario includes child receptors; therefore, protection of child receptors is necessary to ensure overall protection of human health. As a result, cleanup goals for lead and beryllium were developed to be protective of child receptors under the subsistence farming scenario.

The potential for COCs to leach from soils to groundwater was evaluated using *A Seasonal Soil Compartment Model*, SESOIL® [General Sciences Corporation (GCS) 1998]. Results indicate concentrations of COCs detected in soils should not leach through the clay-rich tills to groundwater above ARAR-based cleanup goals.

In the HHRA, all radionuclides are evaluated as carcinogens. Only uranium is considered both a carcinogenic and non-carcinogenic hazard. As discussed previously, uranium can cause kidney damage from toxicity affects. Consequently, the non-carcinogenic properties of uranium were addressed in the HHRA for non-radiological constituents.

Consideration of the cumulative effect of all exposure pathways on risk (and subsequent RBCs) is addressed in several ways for AEC-related COCs. For radionuclides, the RESRAD program was used to look at exposures to constituents in soils and groundwater (and other pathways such as inhalation) simultaneously. For lead, the IEUBK model was used, which, as its name states, examines lead exposures from multiple pathways including soil, water, and food ingestion. For beryllium, the soil cleanup goal is an RBC for a child based on an HI of 1. The groundwater cleanup goal is based on the MCL. It is assumed that because the MCL is an ARAR, that one would not drink groundwater containing beryllium above the MCL. Therefore, the risk due to drinking groundwater containing beryllium at the MCL can be quantified. For a child, this equated to an HQ of approximately 0.2. It is appropriate to round hazard indices to 1 significant figure. Therefore, drinking water containing beryllium at the MCL would not contribute significantly to risks above and beyond risks due to exposure to soils alone.

5.2 ECOLOGICAL RISK

The Ecological Risk Assessment (ERA) included in the 2000 BRA follows EPA's general procedures for ecological assessments in the Superfund Program. The ecological assessment endpoints evaluated potential effects using environmental effects quotients (EEQs) for the constituents of potential ecological concern (CPECs). The EEQs form the quantitative basis of the risk characterization (EPA 1989a). EEQs are computed as the ratio of the total average daily dose (ADD) to the toxicity reference value (TRV). An EEQ greater than “1” indicates there is a potential concern, making the CPEC subject for further investigation. Several preliminary ecological COCs (EEQ >1) were identified in various media at the Luckey site. The majority of the preliminary ecological COCs are in the soil at EU 1 and EU 2. The ERA calculated HIs for the ecological receptors from radionuclides in the soil. The evaluation showed there is no credible risk of harm to these receptors because the HI values are below 0.03 for individual EUs and below 0.05 on a site-wide basis.

In the future, the Luckey site may remain industrial or become completely agricultural similar to surrounding land uses. These current and future land uses allow minimal habitat for ecological receptors and thus minimal exposure to ecological receptors. Terrestrial areas at the site are not currently managed for ecological purposes, nor are there any plans to manage these areas for such purposes in the future. Therefore, COCs have been identified for the protection of human health only. In addition, measures will be taken to prevent releases to the environment and to prevent impacts such as habitat disturbance during remedial alternative implementation. Exposure to COCs in groundwater is limited to human receptors. Addressing the risks to human health in land and groundwater will consequently reduce risks to ecological receptors.

Table 5.1. AEC-Related Constituents of Concern (COCs) for the Current/Future Industrial Worker and Future Subsistence Farmer

IMPACTED SOILS	
Receptors	**COC**
Current/Future Industrial Worker (0-2 feet)	Lead
Future Subsistence Farmer (0-10 feet)	Beryllium, Lead, Radium-226, Thorium-230, Uranium-234, and Uranium-238
GROUNDWATER	
Receptors	**COC**
Current/Future Industrial Worker	Beryllium, Lead, Uranium (total)
Future Subsistence Farmer	Beryllium, Lead, Uranium (total)

Table 5.2. Subsistence Farmer Maximum Cancer Risk Estimates for the Luckey Site

	Location		
Parameter	**EU 1**	**EU 2**	**EU 3**
Medium: (0-2 feet) Soil			
Radium-226	**1.99×10^{-3}**	**1.34×10^{-3}**	**3.29×10^{-4}**
Thorium-230$^{(1)}$	**6.07×10^{-4}**	**7.37×10^{-4}**	
Uranium-234	**$5.61 \times 10^{-5\,(1)}$**	**$3.94 \times 10^{-5\,(1)}$**	$8.34 \times 10^{-6\,(1)}$
Uranium-238	**$7.18 \times 10^{-5\,(1)}$**	**4.92×10^{-5}**	
Total Risk$^{(2)}$	**2.0×10^{-3}**	**1.4×10^{-3}**	**3.3×10^{-4}**
Medium: (0-10 feet) Soil			
Radium-226	**8.6×10^{-4}**	**1.1×10^{-3}**	**3.1×10^{-4}**
Thorium-230$^{(1)}$	**$2.5 \times 10^{-4\,(1)}$**	**$3.4 \times 10^{-4\,(1)}$**	
Uranium-234	**$2.4 \times 10^{-5\,(1)}$**	**$2.2 \times 10^{-5\,(1)}$**	$8.3 \times 10^{-6\,(1)}$
Uranium-238	**$3.1 \times 10^{-5\,(1)}$**	**$2.8 \times 10^{-5\,(1)}$**	
Total Risk$^{(2)}$	**8.8×10^{-4}**	**1.1×10^{-3}**	**3.1×10^{-4}**

Notes: --Radium-226 Risk to Source Ratio includes contributions from lead-210 assuming equilibrium conditions
-- COCs shown in bold; identified for radionuclides with risk > 10^{-5} when total risk > 10^{-4}
Source: FS Report ~ Appendix 3A (USACE 2003)
$^{(1)}$ Maximum risk for individual radionuclides generally occur at Year 0 except where noted with (1), where maximum risk occurs at Year 1000
$^{(2)}$ Maximum total risk occurs at Year 0

Table 5.3. Industrial Worker Maximum Cancer Risk Estimates for the Luckey Site

	Location		
Parameter	**EU 1**	**EU 2**	**EU 3**
Medium: (0-2 feet) Soil			
Radium-226	5.65×10^{-5}	3.78×10^{-5}	9.31×10^{-6}
Thorium-230$^{(1)}$	$1.71 \times 10^{-5\,(1)}$	$2.07 \times 10^{-5\,(1)}$	
Uranium-234	$4.35 \times 10^{-6\,(1)}$	$3.06 \times 10^{-6\,(1)}$	$6.47 \times 10^{-7\,(1)}$
Uranium-238	$5.55 \times 10^{-6\,(1)}$	$3.80 \times 10^{-6\,(1)}$	
Total Risk$^{(2)}$	$6.3 \times 10^{-5\,(1)}$	$5.2 \times 10^{-5\,(1)}$	9.4×10^{-6}
Medium: (0-10 feet) Soil			
Radium-226	2.4×10^{-5}	3.1×10^{-5}	8.7×10^{-6}
Thorium-230$^{(1)}$	$7.1 \times 10^{-6\,(1)}$	$9.6 \times 10^{-6\,(1)}$	
Uranium-234	$1.9 \times 10^{-6\,(1)}$	$1.7 \times 10^{-6\,(1)}$	$6.5 \times 10^{-7\,(1)}$
Uranium-238	$2.4 \times 10^{-6\,(1)}$	$2.1 \times 10^{-6\,(1)}$	
Total Risk$^{(2)}$	$2.7 \times 10^{-5\,(1)}$	$3.3 \times 10^{-5\,(1)}$	8.8×10^{-6}

Notes: --Radium-226 Risk to Source Ratio includes contributions from lead-210 assuming equilibrium conditions
-- COCs shown in bold; identified for radionuclides with risk > 10^{-5} when total risk > 10^{-4}
Source: FS Report ~ Appendix 3A (USACE 2003)
$^{(1)}$ Maximum risk for individual radionuclides generally occur at Year 0 except where noted with (1), where maximum risk occurs at Year 1000
$^{(2)}$ Maximum total risk occurs at Year 0

6.0 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) specify the requirements that remedial alternatives must fulfill in order to protect human health and the environment from contaminants. Essentially, they provide the basis for identifying and evaluating remedial alternatives. The RAOs for the Luckey site are intended to provide long-term protection of human health and the environment. In order to provide this protection, media-specific objectives that identify major contaminants and associated media-specific cleanup goals are developed. These objectives specify the COCs, the exposure routes and receptors, and an acceptable maximum contaminant level for the long-term protection of receptors.

As discussed in Section 5, the BRA includes baseline risk calculations for a number of receptors including a subsistence farmer and an industrial worker. Current land use at the Luckey site is industrial and is expected to remain industrial for the near future. However, it is possible that the future land use could be residential or agricultural for several reasons. Surrounding land use on three sides of the site is agricultural and residential. Agricultural and residential are the dominant land uses throughout Troy Township. There is no other industry in the immediate area and industrial facilities at the site are aging.

As has been stated, the risk calculations and cleanup goals were based on the evaluation of the subsistence farmer scenario, a more conservative receptor as a result of the Ohio Administrative Code (OAC) 3701:1-38-22 requirement to evaluate the "critical group" for radionuclides. In Ohio, the critical group for unrestricted land use has been consistently defined as the subsistence farmer. The subsistence farmer is assumed to represent the critical group at the Luckey site for unrestricted land use. More information can be found in Appendix 3A of the FS (USACE 2003) regarding risk calculations and cleanup goals based on the more conservative subsistence farmer scenario.

RAOs are presented for the following:

- Impacted Soils (on-site and off-site soils/EUs 1, 2, and 3)
- Site-wide Groundwater (EU 7 within the confines of EUs 1, 2, and 3)

Contaminated off-site (EU 3) soils requiring remediation are generally contiguous with contaminated on-site soils (EUs 1 and 2). Therefore, for the identification and evaluation of RAOs and remedial alternatives, they have been combined into one unit collectively named "Impacted Soils."

The RAOs for the impacted soils and groundwater for the Luckey site are as follows:

- Remove or prevent exposure to media containing concentrations of COCs that may pose a risk to human health in excess of a 10^{-4} incremental lifetime cancer risk and/or non-cancer hazard index of 1. COCs are limited to those contaminants associated with AEC activities.
- Minimize the transport of soil COCs to other environmental media (groundwater, surface water, sediment, and air).
- Monitor, control, or actively reduce COCs in groundwater to ensure that, within a limited period of time, concentrations of these constituents are reduced to or below the media-specific cleanup goals at an established point of compliance. The point of compliance and the time period to achieve compliance will comply with federal and state law.
- Restore the site to a condition consistent with its current and anticipated future uses.
- Prevent releases and other impacts that could adversely affect ecological receptors during implementation of the remedial alternative(s).
- Comply with ARARs.

6.1 MEDIA SPECIFIC CLEANUP GOALS

The identification of COCs is presented in Section 5. For these COCs, there are three potential sources of media-specific cleanup goals: concentrations based on site-specific background data, ARARs, and RBCs. The numeric concentrations, or criteria, specified in the ARARs or RBCs exceed background concentrations for all COCs. Therefore, background concentrations have not been selected as media-specific cleanup goals for any COCs.

6.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Agencies responsible for remedial actions under CERCLA must ensure that selected remedies meet ARARs. The following sections describe the ARARs adopted for cleanup of the Luckey site.

6.2.1 Definitions

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under the federal environmental or state environmental or facility citing laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. An applicable requirement directly and fully addresses an element of the remedial action.

Relevant and appropriate requirements are those cleanup or control standards, and other substantive environmental protection requirements, criteria or limitations promulgated under federal environmental or state environmental or facility citing laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, nonetheless address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is suited to the particular site. In addition, only those state standards that are promulgated (specifically stated in laws or regulations adopted pursuant to laws), are identified by the state in a timely manner, and are more stringent than federal requirements that may be applicable or relevant and appropriate.

USACE has determined that the cleanup ARARs for remedial activities at the Luckey site include 10 CFR Part 20 Subpart E, OAC 3701: 1-38-22, Lead Hazard Rule, and SDWA MCLs.

6.2.1.1 <u>10 CFR Part 20 Subpart E – Radionuclides</u>

10 CFR Part 20 Subpart E is applicable to Nuclear Regulatory Commission (NRC) licensed facilities. The regulation was promulgated by the NRC to ensure consistent standards for determining the extent to which lands must be remediated at facilities before remediation can be considered complete and the NRC license terminated. The Luckey site does not have a NRC license. Therefore, the rule is not applicable.

10 CFR Part 20 Subpart E is relevant and appropriate for the Luckey site. The regulation applies to any facility licensed by the NRC to manage special nuclear, source or byproduct radionuclide material that is undergoing decontamination and remediation for release of the property for reuse. The Luckey site is an industrial facility undergoing decontamination in order to remove radioactive residuals so that the property may be released for reuse. The radioactive residuals at the Luckey site are residuals of uranium ore, naturally occurring uranium in the beryllium ore, and/or residuals from contaminated scrap metal sent to the site during AEC activities. In addition, the type and size of the facility at the Luckey site is consistent with the type and size of facilities regulated by 10 CFR Part 20 Subpart E. The media to be

remediated and radioactive constituents of concern at the Luckey site are generally the same or similar to those found at sites subject to the regulation. The standards in the 10 CFR Part 20 Subpart E are:

- Unrestricted use: total effective dose equivalent (TEDE) limited to 25 millirems per year (mrem/yr) for the unrestricted land use receptor and demonstrated to be as low as reasonably achievable (ALARA)
- Restricted use: 25 mrem/yr TEDE to the restricted land-use receptor, ALARA, durable land use controls, license termination plan (LTP), public input, and 100 mrem/yr or 500 mrem/yr to the unrestricted land use receptor if land use controls fail
- Alternate criteria: 100 mrem/yr, ALARA, LTP, and EPA and public input.

In summary, 10 CFR Part 20 Subpart E is both relevant and appropriate for use in the development of media-specific cleanup goals at the Luckey site. The rule addresses situations sufficiently similar to the circumstances of the release at the Luckey site and its use is appropriate to the circumstances of the release. The rule requires evaluation of the "critical group," which in Ohio has been consistently defined as the subsistence farmer scenario for unrestricted use scenarios. Table 6.1 defines the cleanup goals for radionuclides based on 10 CFR Part 20 Subpart E. Activities listed in the table correspond to a dose of 25 mrem/yr for unrestricted land use. If a mixture of radionuclides is present, then the sum of ratios applies.

6.2.1.2 OAC 3701:1-38-22 – Radionuclides

OAC 3701:1-38-22 contains limitations for radionuclides similar to those found in 10 CFR Part 20 Subpart E. The requirement has been promulgated by the State of Ohio, as an agreement state, to ensure consistent standards for determining the extent to which lands in Ohio must be remediated before decommissioning of a site can be considered complete and the state license can be terminated. OAC 3701:1-38-22 is applicable to state-licensed facilities. The Luckey site has no state license; therefore, the regulation is not applicable at the Luckey site.

A state requirement can be an ARAR if it is more stringent than a federal standard, if it is identified in a timely manner, and if it is implemented consistently within the state. OAC 3701:1-38-22 contains the same provisions as 10 CFR Part 20 Subpart E, but one of those provisions is interpreted in a manner that is more stringent than the federal standard. OAC 3701:1-38-22 establishes a standard for unrestricted release of property of 25 mrem/yr plus ALARA, as the total effective dose equivalent to an average member of a critical group. "Critical group" is defined as "the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances" (OAC 3701:1-38-01(A) (35)). In Ohio, the critical group has been consistently defined as the subsistence farmer. This practice is more stringent than that under 10 CFR Part 20 Subpart E. As OAC 3701:1-38-22 is not applicable to the Luckey site, as explained in the previous paragraph, the more stringent interpretation is relevant and appropriate to the Luckey site.

6.2.1.3 Maximum Contaminant Levels - Uranium and Beryllium in Groundwater

The MCLs promulgated pursuant to the SDWA are enforceable standards developed to protect human health from identified adverse effects from drinking water contaminants. The MCL for uranium is found at 40 CFR § 141.66(e) as published in 65 Federal Register (FR) 76708-76748, December 7, 2000 and the MCL for beryllium is found at 40 CFR § 141.62(b) and the OAC at 3745-81-11(B). The Federal MCL for uranium has been established at 30 μg/L. The Federal MCL for beryllium is the same as the State of Ohio drinking water standard, at 4 parts per billion (ppb) or μg/L. MCLs apply to community water systems, defined as those that provide water directly to 25 or more people or supply 15 or more service connections. The system at the Luckey site supplies more than 25 people on a regular basis, so it is a community water system. However, MCLs apply when water comes out at the tap. At the Luckey site, the MCL is being used as a cleanup goal for groundwater and will be measured in the groundwater rather than when the water comes out of the tap. Therefore, the MCLs are not applicable to groundwater at the Luckey site.

The MCLs are relevant and appropriate to the Luckey site. MCLs generally are relevant and appropriate to the cleanup of groundwater that is or may be used for drinking because MCLs are the enforceable standards under the SDWA. The MCLs for carcinogens are within EPA's acceptable risk range and MCLs are protective of human health. At the Luckey site, the MCL value is being cited as the target media-specific cleanup goal. Only the MCL value is being cited as relevant and appropriate. Other provisions of 40 CFR § 141.66, such as monitoring and reporting requirements, are not included. The monitoring and reporting requirements set forth in 40 CFR § 141.66 apply to community water systems that provide drinking water to consumers.

6.2.1.4 National Primary Drinking Water Regulations - Lead in Groundwater

An action level under the SDWA is the regulatory equivalent of an MCL for a drinking water contaminant. In requiring that National Pollution Drinking Water Regulations (NPDWRs) be established for drinking water contaminants, the SDWA provides that standards can be promulgated as MCLs or as treatment techniques. The lead NPDWR health standard found at 40 CFR § 141.80(c) and OAC 3745-81-80(C)(1) is promulgated as a treatment technique, with a trigger action level of 0.015 mg/L.

MCLs are usually used as ARARs for cleanup of contaminated groundwater. As stated in the previous paragraph, the lead action level is equivalent to an MCL for lead. The lead action level would be applicable to water as it comes out of the tap. Groundwater is not the water that comes out of the tap; therefore the lead action level is not applicable to groundwater, but is relevant and appropriate for a groundwater cleanup goal at the Luckey site. At the Luckey site, the action level is being cited as the target media-specific cleanup goal for lead in groundwater, and will be measured in the groundwater rather than when the water comes out of the tap.

At the Luckey site, the action level is being cited as the target media-specific cleanup goal. Only the action level is being cited as relevant and appropriate. Other provisions of 40 CFR § 141.80, such as monitoring and reporting requirements, are not included.

6.3 RISK BASED CONCENTRATIONS

The RBCs for the human health chemical COCs originally were developed in Section 6 of the RI Report in accordance with to the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part B* (EPA 1991). These RBCs were developed to be protective of receptors under the resident farmer scenario, but have been modified to be protective of the subsistence farmer. Appendix 3A of the FS presents an evaluation of the RBCs for beryllium and lead with respect to food intake pathways that could be present under this scenario (i.e., a subsistence farmer scenario). These pathways were not evaluated quantitatively in the RI Report.

Lead does not have toxicological reference values because risks from exposure to lead are better evaluated by predicting the associated blood lead level. Blood lead levels have been accepted as the best measure of external lead dosing. Sensitive populations include preschool age children and fetuses. In these populations, a blood lead level of between 10 and 15 micrograms per deciliter (µg/dL) has been associated with a level at which no adverse effects would be expected. The approach used herein relates intake of lead from soil to blood lead concentrations in residential children and to women of child-bearing age who may be exposed to lead in soil while working at the site. Protection of a hypothetical fetus of an occupationally exposed mother ensures that other workers at the site also will be adequately protected.

A risk-based cleanup goal of 400 mg/kg lead in soil was established by EPA based on the *Revised Interim, Soil Lead Guidance for CERCLA sites Resource Conservation and Recovery Act (RCRA) Corrective Action Facilities* (EPA 1994). This concentration is supported by EPA's IEUBK for Lead in Children (EPA 2001). The IEUBK predicts that 400 mg/kg of lead in soil could cause a six year old resident child (averaged across the preceding 84 months) to have a probability of no greater than 5% of having a blood lead level of 10 μg/dL. For current and future resident farmer scenarios, the RBC for lead is 400 mg/kg.

The IEUBK model used to develop the 400 mg/kg lead in soil value accounts for a number of exposure pathways other than direct exposures to soil that can contribute to an individual's total lead exposure. One of these additional pathways is dietary lead intake. These default dietary intake values account for lead in various food products. While not specifically a subsistence farmer scenario, the default exposure scenario in the IEUBK model does account for the types of pathways that would be evaluated for this receptor. In addition, according to the User's guide for IEUBK (EPA 2001), "Model predictions are not very sensitive to this parameter" - where "this parameter" refers to change in concentration of lead in food. Since this is not a very sensitive input parameter, there is no need to evaluate this pathway further for the subsistence farmer (relative to residential farmer), where a higher concentration of lead in food produced in contaminated soils may be expected. Therefore, the 400 mg/kg is believed to be protective of receptors under a subsistence farmer scenario.

The non-residential RBC for lead was developed using EPA's lead model developed by the Technical Review Workgroup (TRW) (EPA 1996a). The TRW approach for assessing non-residential adult risks utilizes some basic algorithms to relate soil lead intake to blood lead concentrations in women of child bearing age. The basis for the calculation is the relationship between the concentration of lead in soil and the blood lead concentrations in a developing fetus of adult women that have occupational site exposures. In TRW model, the highest acceptable fetal blood lead level was set at the 95th percentile of 10 μg/dl, which is the concentration recommended by EPA and the Centers for Disease Control. The RBC for lead in soil for non-residential adults was calculated as 958 mg/kg. This value is believed to be protective of receptors under an industrial worker scenario.

The media-specific cleanup goal for beryllium is an RBC. The RBC for beryllium is based on the non-carcinogenic risk posed by this compound. For non-carcinogenic compounds, EPA has determined that acceptable exposure levels are concentrations that do not exceed an HI of 1. If multiple COCs have similar toxic effects or target the same organ, then the total HI for these compounds must not exceed 1. Exposure to beryllium can cause intestinal lesions and berylliosis, a disease of the lungs. No other COCs have similar toxic effects or target the same organs; therefore the RBC for beryllium corresponds to an HI of 1. The cancer risk from exposure to beryllium at the RBC of 131 mg/kg is approximately 10^{-8}.

In developing the RBC, the following exposure pathways were evaluated quantitatively; soil ingestion, dermal contact, and inhalation of fugitive dust. In addition, food intake pathways consistent with a subsistence farmer scenario were considered. Food intake pathways were evaluated quantitatively (ingestion of home-grown produce) and qualitatively (ingestion of meat, milk, and fish). Evaluation of the food pathways revealed that only plant uptake/consumption of home-grown produce contributed to risk from beryllium. Therefore, this pathway along with soil ingestion, dermal contact, and inhalation of fugitive dust were used to calculate an RBC of 131 mg/kg beryllium in soil, which corresponds to an HI of 1. This evaluation is presented in Appendix 3A of the FS. The RBC was originally calculated in the RI and was subsequently revised for a subsistence farmer.

6.4 SELECTED CLEANUP GOALS

Table 6.1 presents the media-specific cleanup goals for impacted soils and groundwater. Where multiple receptors existed, the selected media-specific cleanup goal corresponds to the most sensitive receptors, (which corresponds to the lowest of the potential media-specific cleanup goals for the constituent). These goals were used to develop the volume estimates for contaminated media and also will form the basis for confirmatory sampling.

The cleanup goals selected for impacted soils also were evaluated in the FS using SESOIL (GCS 1998) and RESRAD to assess their protectiveness of groundwater. SESOIL and RESRAD modeling results indicate when using realistic input parameters (e.g., distribution coefficients [Kd], hydraulic parameters), AEC-related constituents do not leach through the clay-rich tills at concentrations exceeding their respective risk- or ARAR-based cleanup goals. For example, the models indicate uranium will leach to groundwater at concentrations above the cleanup goal when a Kd of 15 mL/g is used. Further evaluation indicates background concentrations of uranium in the soil also would leach to the groundwater above the uranium cleanup goal when a Kd of 15 mL/g is used. Therefore, widespread concentrations of uranium in groundwater above its cleanup goal should occur if this were a realistic Kd value. Since widespread contamination does not occur, a Kd of 15 mL/g is not realistic for the site. The SESOIL and RESRAD evaluation indicates concentrations in soils, at or below the cleanup goals, do not leach to groundwater at concentrations exceeding the drinking water standards and thus are protective of groundwater.

ARAR-based cleanup goals presented in Table 6.1 for radionuclides in soil correspond to a TEDE of 25 mrem/yr (unrestricted land use). When multiple radionuclides are present, activities need to be adjusted so the total activity does not exceed the TEDE. In other words, the soil cleanup goals presented in Table 6.1 assume only one of the radionuclides is present. USACE utilizes the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (DOD 2000) to assure exposure to all radiological COCs combined will not exceed the respective dose limit.

During implementation of the selected soil and groundwater remedial alternatives (including confirmatory sampling) cleanup goals will be used as target concentrations (e.g., 95% upper confidence limit of the mean) of the COCs that may remain in the remediated exposure units. In addition, not to exceed concentrations will be developed to ensure no localized areas remain potentially posing unacceptable risk. Presentation of this cleanup confirmation methodology will occur in the detailed design document following approval of this Proposed Plan.

Table 6.1. COCs and Selected Media-specific Cleanup Goals for the Luckey Site

IMPACTED SOILS			
Receptors	**COC**	**Media-specific Cleanup Goal** [a]	**Source**
Future Subsistence Farmer	Beryllium	131 mg/kg	RBC
	Lead	400 mg/kg	RBC
	Radium-226	2.0 pCi/g[b]	ARAR
	Thorium-230	5.8 pCi/g[b]	ARAR
	Uranium-234	26 pCi/g[b]	ARAR
	Uranium-238	26 pCi/g[b]	ARAR
GROUNDWATER			
Receptors	**COC**	**Media-specific Cleanup Goal** [a]	**Source**
Future Subsistence Farmer	Beryllium	4 μg/L	ARAR
	Lead	15 μg/L	ARAR
	Uranium (total)	30 μg/L	ARAR

[a] SESOIL modeling results indicate risk-based and/or ARAR-based cleanup goals selected for soils are protective of groundwater.
[b] Soil cleanup goals for radionuclides represent activity levels above site background activity corresponding to 25 mrem/yr (10 CFR Part 20 Subpart E and OAC 3701:1-38-22). If a mixture of radionuclides is present, then the sum of ratios applies per MARSSIM. For example, use the 25 mrem/yr unrestricted land use cleanup goals for soil to get the following sum of the ratios equation:

$$SOR = \frac{Radium - 226}{2.0\,pCi/g} + \frac{Thorium - 230}{5.8\,pCi/g} + \frac{Uranium - 234}{26\,pCi/g} + \frac{Uranium - 238}{26\,pCi/g}$$

where SOR = sum of the ratios result
Radium-226 = net Radium-226 soil concentrations
Thorium-230 = net Thorium-230 soil concentrations
Uranium-234 = net Uranium-234 soil concentrations
Uranium-238 = net Uranium-238 soil concentrations
Net soil concentrations exclude background.

7.0 SUMMARY OF REMEDIAL ALTERNATIVES

This section summarizes remedial alternatives developed for the Luckey site. The remedial alternatives were constructed by combining general response actions, technology types and process options. Remedial alternatives should assure adequate protection of human health and the environment, achieve RAOs, meet ARARs, and permanently and significantly reduce the volume, toxicity, and/or mobility of site-related contaminants.

The remedial alternatives presented in the FS address soil and groundwater contamination at the Luckey site. The alternatives encompass a range of potential actions:

- Alternative 1: No Action (Soils and Groundwater)
- Alternative 2: Limited Action (Soils and Groundwater) ~ Restricted Land Use
- Alternative 3: Consolidation and Capping (Soils) ~ Restricted Land Use
- Alternative 4: Excavation of Soils and Off-site Disposal (Soils) ~ Industrial Land Use
- Alternative 5: Excavation of Soils and Off-site Disposal (Soils) ~ Unrestricted Land Use
- Alternative 6: Excavation of Soils, Treatment, and Off-site Disposal (Soils) ~ Unrestricted Land Use
- Alternative 7: Monitored Natural Attenuation (Groundwater) ~ Unrestricted Land Use
- Alternative 8: Active Groundwater Treatment – Ex Situ (Groundwater) ~ Unrestricted Land Use
- Alternative 9: Electrokinetics (Groundwater) ~ Unrestricted Land Use

Alternative 1 is the no-action response required under the NCP and is inclusive of both soil and groundwater. Alternative 2 also is inclusive of soil and groundwater. It relies on passive MNA for groundwater contamination in conjunction with limited site improvements and land use controls. No source control or removal actions are implemented with Alternative 2.

Alternatives 3, 4, 5, and 6 address soils and utilize short-term monitoring in combination with other containment, removal, and/or treatment technologies. Alternatives 3 and 4 also would require long-term monitoring and five-year reviews, since impacted soils would remain on site above unlimited land use cleanup goals thereby not allowing unlimited use and unrestricted exposure at the property. Alternative 3 uses consolidation combined with containment technologies. Removal technologies are included in Alternatives 4, 5, and 6. Alternatives 4 and 5 rely primarily on off-site disposal. Alternative 6 utilizes removal and off-site disposal combined with soil treatment.

Current land use at the Luckey site is industrial and is expected to remain industrial for the near future. However, it is possible that future use could be residential or agricultural since surrounding land use is primarily agricultural and residential and these are the dominant land uses throughout Troy Township. In addition, there is no other industry in the immediate area and the most recent deed to the property lists no specific restrictions or easements that would preclude residential or agricultural land use. Since Alternatives 2, 3, and 4 do not achieve unrestricted land use of the Luckey site, these Alternatives are not considered further in this PP. Only Alternatives 5 and 6 are considered further to address impacted soils.

Groundwater treatment alternatives are presented in Alternatives 7, 8, and 9 and include MNA, active remediation (pump and treat), and electrokinetics, respectively. Long-term monitoring and five-year reviews would be conducted until concentrations in groundwater are achieved allowing unlimited use and unrestricted exposure at the property.

The five remaining remedial alternatives are described below. The remedy selected for the Luckey site will include a soils alternative and a groundwater alternative. Time periods for environmental monitoring are specific to each alternative. The length of time depends upon the relevant ARARs and the specific technologies employed under each alternative. For the no action alternative, the assumed length of time is zero. For Alternatives 5 and 6, where soil contamination is removed from the Luckey site, the length of time is assumed to be zero years. For Alternatives 7, 8, and 9, groundwater monitoring will continue for the duration of the remedy. This period ranges from 40 to 150 years.

7.1 ALTERNATIVE 1: NO ACTION (SOILS AND GROUNDWATER)

This alternative would provide no further remedial action at the Luckey site and is included as a baseline against which other alternatives can be compared. Although land use controls are in place at the site, these would be left in place, but not necessarily maintained under this alternative. However, the site is assumed to operate in compliance with existing regulations that impose limitations on occupational exposures. Five-year reviews would be conducted in accordance with CERCLA 121(c).

7.2 ALTERNATIVE 5: EXCAVATION OF SOILS AND OFF-SITE DISPOSAL (SOILS) ~ UNRESTRICTED LAND USE

This alternative would involve the removal and transportation of impacted soils above unrestricted land use cleanup goals for off-site disposal. Impacted soils would be excavated and transported to an off-site disposal facility licensed or permitted to accept these wastes. Clean backfill would be placed in excavated areas. Remedial action would require approximately three (2.9) years to complete. There is no O & M associated with this alternative because impacted soils are removed from the site.

Alternative 7, 8, or 9 would be implemented with this alternative to remediate groundwater. The impact of this alternative on each of the groundwater alternatives is the same. A conceptualization of this alternative is shown in Figure 7.1.

7.3 ALTERNATIVE 6: EXCAVATION OF SOILS, TREATMENT, AND OFF-SITE DISPOSAL (SOILS) ~ UNRESTRICTED LAND USE

This alternative is similar to Alternative 5 with respect to the excavation and transportation of soils, cleanup goals, and off-site disposal of impacted soils. However, this alternative incorporates treatment to reduce the volume of contaminated materials requiring disposal. Soils successfully treated to meet cleanup goals would be used as backfill in excavated areas. Impacted soils and treatment residuals above unrestricted land use cleanup goals would be transported to an off-site disposal facility licensed or permitted to accept these wastes. Remedial action would require approximately three (3) years to complete. There is no O & M associated with this alternative because impacted soils are removed from the site.

Alternative 7, 8, or 9 would be implemented with this alternative to remediate groundwater. The impact of this alternative on each of the groundwater alternatives is the same. A conceptualization of this alternative is similar to Alternative 5 and is shown in Figure 7.1.

7.4 ALTERNATIVE 7: MONITORED NATURAL ATTENUATION (GROUNDWATER) ~ UNRESTRICTED LAND USE

This alternative consists of natural attenuation and monitoring the reduction in groundwater contaminant concentrations over time and would be implemented in conjunction with Alternative 5 or 6, which effectively remove the sources contributing to groundwater contamination. Groundwater remedial action would require zero years to complete with a potential 150-year O&M period for groundwater monitoring. Groundwater monitoring would be conducted in accordance with the monitoring program for the first five to 10 years after source removal, after which the efficacy of monitored natural attenuation (MNA) will be confirmed. Land use controls would include land use restrictions to prohibit changes in groundwater use and periodic inspection of the site to determine any changes in land use. Five-year reviews would be conducted in accordance with CERCLA 121(c).

A conceptualization of this alternative is shown in Figure 7.2.

7.5 ALTERNATIVE 8: ACTIVE GROUNDWATER TREATMENT - EX SITU (GROUNDWATER) ~ UNRESTRICTED LAND USE

This alternative consists of actively treating groundwater contaminant concentrations using a pump and treat system involving adsorption of uranium and beryllium onto solid media. It would be implemented in conjunction with Alternative 5 or 6, which effectively remove the sources contributing to groundwater contamination. Groundwater remedial action would require 80 years for beryllium and 10 years for uranium to complete with an 80-year O&M period for groundwater monitoring. Groundwater monitoring would be performed annually for the first 5 years after source removal to confirm effectiveness. Land use controls would include continuing the existing and installing new access restrictions; maintaining fencing and signs; land use restrictions to prohibit changes in groundwater use; and periodic inspection of the site to determine any changes in land use. Five-year reviews would be conducted in accordance with CERCLA 121(c).

A conceptualization of the alternative is similar to Alternative 7 and is shown in Figure 7.2.

7.6 ALTERNATIVE 9: ELECTROKINETICS (GROUNDWATER) ~ UNRESTRICTED LAND USE

Alternative 9 involves drilling a grid pattern of wells through the saturated clay to the fractured bedrock, and emplacement of electrodes encased in permeable membranes filled with electrolyte. The electrodes would be connected to a power source, resulting in the metal contaminants in groundwater being driven to the anodes for removal and disposal. This alternative would be implemented in conjunction with Alternative 5 or 6, which effectively remove the sources contributing to groundwater contamination. Groundwater monitoring would be performed annually for the first 5 years after source removal for up to 15 years during electrokinetic treatment. Groundwater monitoring of constituents in bedrock would continue up to an additional 25 years. Land use controls would include continuing the existing and installing new access restrictions; maintaining fencing and signs; land use restrictions to prohibit changes in groundwater uses; and periodic inspection of the site to determine any changes in land use. Five-year reviews would be conducted in accordance with CERCLA 121(c).

A conceptualization of this alternative is shown in Figure 7.3.

8.0 EVALUATION OF REMEDIAL ALTERNATIVES

8.1 INTRODUCTION

This section presents a detailed analysis of the five remedial alternatives considered for further evaluation in this PP. From this set of alternatives, one or more will ultimately be chosen as the remedy for the soils and groundwater at the Luckey site. Under the CERCLA remedy selection process, the preferred remedial alternative is suggested in the Proposed Plan (PP) and set forth in final form in the Record of Decision (ROD). A detailed evaluation of each alternative is performed in this section to provide the basis and rationale for identifying a preferred remedy and preparing the PP.

To ensure the analysis provides information of sufficient quality and quantity to justify the selection of a remedy, it is helpful to understand the requirements of the remedy selection process. This process is driven by the requirements set forth in CERCLA Section 121. In accordance with these requirements (EPA 1988), remedial actions must:

- Be protective of human health and the environment
- Attain ARARs or provide grounds for justifying a waiver
- Be cost effective
- Use permanent solutions and alternative treatment technologies to the maximum extent practicable
- Satisfy the preference for treatment that, as a principle element, reduces volume, toxicity, or mobility.

CERCLA emphasizes long-term effectiveness and related considerations for each remedial alternative. These statutory considerations include:

- Long-term uncertainties associated with land disposal
- The goals, objectives, and requirements of the Solid Waste Disposal Act
- The persistence, toxicity, and mobility of hazardous substances, and their propensity to bio-accumulate
- Short- and long-term potential for adverse health effects from human exposure
- Long-term maintenance costs
- The potential for future remedial action costs if the remedial alternative in question were to fail
- The potential threat to human health and the environment associated with excavation, transportation, and re-disposal, or containment.

These statutory requirements are implemented through the use of nine evaluation criteria presented in the NCP. These nine criteria are grouped into threshold criteria, balancing criteria, and modifying criteria, as described below. Following this description, in Section 8.2, is a detailed analysis of each alternative against the evaluation criteria that includes further definition of each alternative, if necessary, to more accurately describe volumes or areas of contaminated media or technologies. Following this detailed analysis is a brief description of considerations common to all alternatives (Section 8.3) and a comparative analysis (Section 9) among the alternatives to assess how each will perform with respect to the criteria.

8.1.1 Threshold Criteria

Two of the NCP evaluation criteria relate directly to statutory findings that must be made in the ROD. These criteria are thus considered to be threshold criteria that must be met by any remedy in order to be selected. The criteria are:

(1) Overall protection of human health and the environment and
(2) Compliance with ARARs.

Each alternative must be evaluated to determine how it achieves and maintains protection of human health and the environment. Similarly, each remedial alternative must be assessed to determine how it complies with ARARs, or, if a waiver is required, an explanation of why a waiver is justified. An alternative is considered to be protective of human health and the environment if it complies with media-specific cleanup goals.

8.1.2 Balancing Criteria

The five balancing criteria represent the primary criteria upon which the detailed analysis of alternatives and the comparison of alternatives are based. They are:

(1) Long-term effectiveness and permanence,
(2) Reduction of toxicity, mobility, or volume through treatment,
(3) Short-term effectiveness,
(4) Implementability, and
(5) Cost.

Long-term effectiveness and permanence is an evaluation of the magnitude of residual risk (risk remaining after implementation of the alternative) and the adequacy and reliability of controls used to manage the remaining waste (untreated waste and treatment residuals) long term. Alternatives that provide the highest degree of long-term effectiveness and permanence leave little or no untreated waste at the site, make long-term maintenance and monitoring unnecessary, and minimize the need for land use controls.

Reduction of toxicity, mobility, or volume through treatment is an evaluation of the ability of the alternative to reduce the toxicity, mobility, or volume of the waste. The irreversibility of the treatment process and the type and quantity of residuals remaining after treatment also are assessed.

Short-term effectiveness addresses the protection of workers and the community during the remedial action, the environmental effects of implementing the action, and the time required to achieve media-specific cleanup goals.

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation. Technical feasibility assesses the ability to construct and operate a technology, the reliability of the technology, the ease in undertaking additional remedial actions, and the ability to monitor the effectiveness of the alternative. Administrative feasibility is addressed in terms of the ability to obtain approval from federal, state, and local agencies.

Cost analyses provide an estimate of the dollar cost of each alternative. Detailed cost estimates are provided in Appendix 6B of the FS. The cost estimates are based on estimating reference manuals, existing USACE contracts, historical costs, vendor quotes, and engineering estimates. The primary methodology used is a quantity take-off method in which costs are calculated based on a unit cost multiplied by quantity or other input parameters. Costs are reported in base year 2002 dollars, or present value (future costs are converted to year 2002 dollars using a 7 percent discount factor). The present value analysis is a method to evaluate expenditures, either capital or O&M, which occur over different time periods. Present value calculations allow for cost comparisons of different remedial alternatives on the basis of a single cost figure. The capital costs have not been discounted due to their relatively short implementation duration. The cost estimates are for guidance in project evaluation and implementation and are believed to be accurate within a range of -30 percent to +50 percent in accordance with EPA guidance (EPA 2000). The detail used to develop these costs should provide more certainty. Actual costs could be higher than estimated due to unexpected site conditions or potential delays.

8.1.3 Modifying Criteria

The two modifying criteria below will be evaluated as part of the ROD after the public has had an opportunity to comment on the PP. They are:

(8) State acceptance and
(9) Community acceptance.

State Acceptance considers comments received from agencies of the State of Ohio. The primary state agencies supporting this investigation are the Ohio EPA and the ODH. Comments will be accepted from state agencies on the FS and on the preferred remedy presented in this PP. This criterion will be addressed in the responsiveness summary of the ROD.

Community Acceptance considers comments made by the community, including stakeholders, on the alternatives being considered. Input has been encouraged during the ongoing investigation process to ensure the remedy ultimately selected for the Luckey site is acceptable to the public. Comments will be accepted from the community on the FS and on the preferred remedy presented in this PP. This criterion will be addressed in the responsiveness summary of the ROD.

Because the actions above have not yet taken place, the detailed analysis of alternatives presented below cannot account for the modifying criteria at this time. Therefore, the detailed analysis is carried out only for the threshold and balancing criteria, or the first seven of the nine criteria.

8.2 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents a detailed analysis of the retained remedial alternatives. Each alternative is described and evaluated against the criteria outlined in Section 8.1. A summary of this evaluation is included in Table 8.2. Site characterization data and a number of analytical tools provide the foundation for evaluation of the alternatives.

Much of the Luckey site information necessary to evaluate the potential alternatives was compiled and presented in the RI Report (USACE 2000a). Section 2 of this PP presents a summary of pertinent information regarding the environmental setting, site history, and site characterization including nature and extent of contamination, contaminant fate and transport characteristics, and results from the baseline risk assessment. In addition, the estimated extent and volume of contaminants in soils at the site are summarized in Section 3.3 of this PP.

Other analytical tools employed in the evaluation include modeling that permits predictive analysis while considering site characterization data. Groundwater flow conditions at the site were evaluated through the development of a groundwater flow model (USACE 2001). The flow model reproduces observed groundwater flow conditions at the site and forms the basis for predictive simulations of contaminant transport in groundwater under each of the alternatives evaluated.

8.2.1 Alternative 1: No Action (Soils and Groundwater)

Under this alternative, impacted soils would remain at current locations. Since impacted soils would remain in place, their impact on groundwater would be unabated. Existing land use controls (maintenance of lagoon covers) and access controls (site security fencing) would be left in place but not necessarily maintained. Environmental monitoring would not be performed. In addition, no restrictions on land use would be pursued. However, the site is assumed to operate in compliance with existing regulations that impose limitations on occupational exposures.

8.2.1.1 Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health. The BRA for the Luckey site indicates potential future human health risks could exceed the CERCLA acceptable range of 10^{-4} to 10^{-6} ILCR for radiological constituents. The potential future human health risks also could exceed an HI of 1 for non-carcinogenic compounds. For current receptor conditions (i.e., industrial worker), risk levels are within the acceptable cancer risk range (10^{-4} to 10^{-6} ILCR) and do not exceed an HI of 1, however, exposures to lead in soils potentially pose unacceptable risk.

The BRA identified risks to ecological receptors on the site due to beryllium and lead in the on- and off-site soils. Under this alternative there would be no mitigation of these risks. There were no ecological effects quotients or HIs greater than 1 for radionuclides.

Alternative 1 provides no additional protection to human health and the environment over baseline conditions. Luckey site soils that pose potentially unacceptable risks under future-use scenarios (e.g., subsistence/residential farmer/industrial worker) would not be remediated. The risks from direct contact, ingestion, external gamma radiation, and inhalation would continue and could increase over time because current access controls, such as fencing and the existing caps on the lagoons, may not be maintained. The potential for human exposure to contaminants and the potential for off-site migration could increase over time as a result of anthropogenic and natural processes and the deterioration of existing structures and paved surfaces.

Risks associated with exposure to contaminated groundwater are minimal under current conditions, as evaluated in the BRA (USACE 2000a). Beryllium, lead, and uranium were detected in groundwater above ARAR-based cleanup goals. The contamination is isolated and regular monitoring of the on-site monitoring wells and East Production Well is occurring. Beryllium, lead, and uranium were detected in the groundwater encountered immediately above bedrock or in the shallow bedrock (with the exception of the West Production Well). Beryllium was consistently detected above the ARAR-based cleanup goal in MW-01(I), MW-02(S), and the West Production Well. Lead was consistently detected above the ARAR-based cleanup goal in MW-21(I). Uranium was consistently detected above the ARAR-based cleanup goal in MW-24(S).

Groundwater at Luckey is expected to remain above ARAR-based cleanup goals into the future under this alternative. Groundwater will periodically come into contact with contaminated materials beneath the trenches and lagoons resulting in periodic impacts to groundwater. In the future, groundwater containing beryllium above background may migrate off site. Beryllium concentrations in off-site groundwater are expected to exceed ARAR-based cleanup goals for 1,000 years immediately adjacent to the northern fence line (near MW-01(I), MW-02(S), and MW-26(S)). The predicted concentrations under pumping or non-pumping conditions are expected to be less than the maximum concentrations currently detected on site and are not expected to exceed ARAR-based cleanup goals at the location of current receptors (i.e., East Production Well or resident farmer north of the site). Periodic releases of beryllium to groundwater from beneath the trenches are expected to attenuate within a distance of 300 feet north of the site. Periodic releases of lead and uranium to groundwater are not expected to migrate off site above ARAR-based cleanup goals.

8.2.1.2 Compliance with ARARs

Proposed ARARs for the Luckey site are developed in Section 6 of this PP. For convenience, these ARARs, which apply to all of the remedial alternatives, are summarized below:

- An unconditional release TEDE standard of 25 mrem/yr assuming the TEDE is demonstrated to be ALARA for radionuclides in soil (reference 10 CFR Part 20 Subpart E and OAC 3701:1-38-22).
- A conditional release TEDE standard of 25 plus ALARA (with durable land use controls) or 100 mrem/yr plus ALARA (if controls are lost) for radionuclides in soil (reference 10 CFR Part 20 Subpart E).
- An MCL of 4 μg/L for beryllium in groundwater that is an actual or potential source of drinking water (reference 40 CFR Section 141.62(b) and OAC 3745-81-11[B]).
- An action level of 15 μg/L for lead in groundwater that is an actual or potential source of drinking water (reference 40 CFR Section 141.80(c)(1) and OAC 3745-81-80(C)(1)).
- An MCL of 30 μg/L for uranium in groundwater that is an actual or potential source of drinking water (reference 40 CFR Section 141.66[e]).

Alternative 1 does not achieve the media-specific cleanup goals established by these ARARs. Concentrations of radionuclides in the soil would continue to exceed the ARAR-based cleanup goals. Groundwater contaminants (beryllium, lead, and uranium) also would continue to exceed ARAR-based cleanup goals, and could potentially migrate off site.

8.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 includes no long-term management measures to prevent exposures to or the spread of contamination. Potential future risks occur at levels that exceed the CERCLA acceptable cancer risk range. Although existing site security could provide limited control of exposures to site contaminants, this alternative does not assure controls will remain in place and does not provide any additional new controls in the future. Under future land-use scenarios, there are potential unacceptable risks to human health and the environment, since the impacted soils would remain in place with no controls.

Contamination of groundwater would continue since the source of contamination, site soils, would remain in place. Groundwater modeling results, in conjunction with site characterization data, indicate leaching of constituents through the soils is currently not the primary mechanism for the observed concentrations in groundwater. Rather, periodic saturation of the materials in the disposal trenches and subsequent release to groundwater are more likely. These processes would continue to impact groundwater at concentrations exceeding ARAR-based cleanup goals in the shallow groundwater (upper 5-10 feet of saturated thickness). Periodic direct contact between groundwater and contaminated materials beneath the trenches and lagoons is expected to occur for over 1,000 years into the future as well. Leaching of AEC-related constituents through clay-rich till is not expected to cause groundwater impacts above ARAR-based cleanup goals.

Under this alternative, natural attenuation is the only means for reducing contaminant concentrations in groundwater. Beryllium, lead, and uranium do not biodegrade. The primary mechanisms for attenuation of these contaminants consist of sorption of the aquifer matrix (i.e., soil), chemical reactions, and mixing through mechanical dispersion and diffusion.

Contaminants in groundwater are predicted to migrate towards the East Production Well and remain within its hydraulic influence as long as the well operates at its current measured pumping rate (approximately 70 gal/min). Modeling of observed beryllium, lead, and uranium concentrations in groundwater at the site predicts future concentrations at the East Production Well will never exceed ARAR-based cleanup goals.

Beryllium, lead, and uranium tend to sorb to soils, with the amount of sorption increasing as silt and clay content increase. As a result, these constituents tend to move very slowly in overburden areas where they encounter predominantly clay-rich tills. Sorption of contaminants within the bedrock aquifer is expected to be significantly less, permitting the contaminants to migrate more rapidly. However, as the contaminants move through the bedrock, concentrations are reduced through mechanical dispersion and diffusion. As a result of these processes, impacts to groundwater above ARAR-based cleanup goals are generally expected to remain in the areas, or within about 300 feet of the areas, where they are currently observed.

Under the future land use scenario (e.g., subsistence farmer), if no action were taken, receptors could access contaminants (beryllium, lead, and uranium) in shallow groundwater above ARAR-based cleanup goals. However, concentrations do not necessarily pose unacceptable risk. Modeling results predict that although concentrations exceed ARAR-based cleanup goals in the shallow bedrock and overburden, ARAR-based cleanup goals are not exceeded in deeper bedrock where domestic supply wells are generally installed.

8.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No reduction in contaminant toxicity, mobility, or volume is achieved, because no treatment process is proposed under this alternative.

8.2.1.5 Short-Term Effectiveness

There are no significant short-term human health risks associated with Alternative 1 beyond baseline conditions. There would be no additional short-term health risks to the community, because no remedial actions would be implemented. There would be no transportation risks nor would workers be exposed to any additional health risks. Alternative 1 would not directly cause adverse impacts on soils, air quality, water resources, or biotic resources.

No action allows impacted soils to remain. Current (industrial) and future (industrial or agricultural/subsistence farmer/residential) land uses allow for minimal habitat for ecological receptors and thus minimal exposure (i.e., minimal risk to ecological receptors). The time until protection is achieved is indefinite because no action would be taken.

8.2.1.6 Implementability

No actions are proposed under this alternative.

8.2.1.7 Cost

The present value cost to complete Alternative 1 is zero. As discussed earlier, the no action alternative does not meet NCP threshold evaluation criteria (overall protection of human health and the environment/compliance with ARARs). Therefore, the no action alternative is not likely to be selected as the preferred remedial alternative for the site. As the no action alternative is not likely to be selected, costs associated with conducting five-year reviews will not be determined for this alternative. In addition, there would be no capital costs.

8.2.2 Alternative 5: Excavation of Soils and Off-site Disposal (Soils) ~ Unrestricted Land Use

Alternative 5 includes excavation and off-site disposal to remove impacted soils exceeding established media-specific cleanup goals for unrestricted land use (subsistence farmer receptor). Soils above the established cleanup goals would be excavated and shipped off site to a permitted disposal facility. Contaminated rubble, which may be encountered from some areas of the site, would be crushed or broken up to meet requirements of the receiving facility. Other required technologies include land use controls, monitoring, short-term containment technologies, and truck and rail transportation. Alternative 5 only addresses soils. Groundwater remediation is discussed in Alternatives 7, 8, and 9. One of those alternatives would be implemented in conjunction with this alternative to provide a complete remediation solution.

8.2.2.1 Overall Protection of Human Health and the Environment

In general, the long-term protectiveness of this alternative is high. Alternative 5 includes removal of soil to meet the media-specific cleanup goals in surface and subsurface soil. Remedial activities would address non-radiological and radiological contaminants. Removing soil containing contaminants above media-specific cleanup goals would limit risks to within the CERCLA acceptable cancer risk range and to less than the non-carcinogenic HI of 1. Exposures to lead would be reduced to acceptable levels based on EPA models. In addition, exposure would be below dose-based limits and recontamination of groundwater would be eliminated. Therefore, this alternative is protective of human health.

Current (industrial) and future (industrial or agricultural/subsistence farmer/residential) land uses allow for minimal habitat for ecological receptors and thus minimal exposure. The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit the site.

8.2.2.2 Compliance with ARARs

ARAR-based cleanup goals selected for the Luckey site were detailed under Alternative 1. Under Alternative 5, all soil cleanup goals established by ARARs would be satisfied.

8.2.2.3 Long-Term Effectiveness and Permanence

Alternative 5 is protective in the long term. All soils above the media-specific cleanup goals are excavated and transported off site for disposal, thereby mitigating risks to human health and the environment. Removal of impacted soils would effectively reduce the long-term contamination of groundwater. Remediation of the current groundwater contamination is covered in Alternatives 7, 8, and 9.

8.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No reduction in impacted soils toxicity, mobility, or volume is achieved. This alternative uses excavation and off-site disposal, but not treatment, to remove soil exceeding media-specific cleanup goals.

8.2.2.5 <u>Short-Term Effectiveness</u>

Excavated soils will be transported by truck to a staging area where intermodals or trucks will be loaded and transported (via truck) to a railroad spur or the local disposal facility. Approximately 64 percent of the soil to be remediated can be disposed at local facilities, since it is neither radioactive nor hazardous. The remainder will be shipped to an out-of-state disposal facility via railcar. Risks will be mitigated during transport by inspecting vehicles before and after use, decontaminating when needed, covering the transported waste, observing safety protocols, following pre-designated routes, and limiting the distance the waste is transported in vehicles. Transportation risks (e.g., from continuous leaks and to trespassers specifically) increase with distance and volume. Transportation of radioactively contaminated materials to an off-site disposal facility would strictly comply with all applicable state and federal regulations. Pre-designated routes would be traveled and an emergency response program would be developed to respond to any accidents. Mitigation measures would be used to ensure minimization of short-term impacts, such as erosion and dust control during construction.

<u>Community</u>: Minimal risk to the community and current tenant personnel is expected during excavation of impacted soils. Air quality could be affected by the release of particulates and radon during soil excavation. A network of ambient air monitors would be installed to measure dust emissions during construction activities. Engineering controls would be implemented to ensure emissions do not exceed levels that could pose a risk to human health. Land use controls also would be used to restrict public access to construction areas. Noise levels would increase due to the use of heavy equipment during normal working hours. Other short-term impacts to the community could include traffic disruptions during construction. In addition, the impact of the remediation on the local economy would be fairly significant. An outside contractor would perform the work; therefore, mostly secondary jobs would be impacted. Few local residents would be hired directly by the remediation contractors. However, the remediation workers would be spending money in the local economy for the duration of the remediation.

The short-term use of the site for remedial activities could adversely affect current tenant operations. Planning will be done before implementation of this and any alternative to reduce risks to the current tenants (personnel and operations). Long-term effects on the current tenants also will be taken into account when analyzing this alternative. Certain land use controls, such as easements, may make transfer of the property from one owner to another more difficult.

<u>Workers</u>: Potential occupational exposures to remedial construction workers would result from direct exposure to gamma radiation from impacted soils and from inhalation and ingestion of airborne particulates. Workers would follow an approved site-specific Health and Safety Plan (HASP) describing appropriate levels of personal protective equipment (PPE), personal monitoring devices, and decontamination procedures to minimize exposure to and the spread of contamination. The potential for worker exposure is mitigated through these measures. Personal monitoring devices and a medical monitoring program would be used to ensure workers do not receive exposures resulting in adverse health effects. For the types of contaminants at the Luckey site and the types of actions being considered, there is minimal potential for worker exposure when these measures are implemented appropriately.

Heavy machinery will be operated on site during the implementation of this alternative. Workers will be at risk for accidents and injuries associated with the use of this equipment. These construction risks will be consistent with similar activities at non-contaminated construction sites. The use of PPE, however, could increase some types of construction risks due to the restrictive nature of PPE. All machinery and equipment would be inspected after use, surveyed for radioactivity, and decontaminated if necessary. No occupational or safety barriers that would prevent the implementation of this remedy are foreseen.

Ecological Resources: Terrestrial biota would be impacted by disruption of existing habitat during implementation of remedial actions under Alternative 5. These impacts would be temporary, and would not have significant impact on entire populations, because the existing habitat would be reestablished and other biota similar to those originally present would be expected to rapidly re-colonize the area after application of the final soil cover. Offsite aquatic habitat in downstream areas of Toussaint Creek could be impacted by increased sediment loading due to surface runoff. Erosion control measures would be implemented to minimize these impacts. Consultation with the USFWS and the Ohio Department of Natural Resources (Ohio DNR) indicates no protected species are known to be present at the site.

Engineering Controls: Potential releases to the environment would be controlled with management and engineering practices. Runoff control is especially important for any area draining to a wetland. The only natural habitat remaining on the site is the wetland area in the east-central portion of the property. The excavation of soil in the wetland would be expected to result in the loss of the characteristics and functions of the wetland, at least during the implementation phase of the remedial action. The wetland could be restored after remedial action is completed. Federal and state wetlands regulations would be followed. Any designated wetlands will be addressed to meet Clean Water Act requirements for protection or mitigation of wetlands impacts.

Hay bales and silt fences would be used to prevent soil transport in surface water runoff. Wetting surface materials with water or dust control chemicals would mitigate fugitive dust impacts. Regular surface wetting can reduce the dust loads from construction sites and storage piles by as much as 50 percent. Chemical wetting agents also can increase the reduction significantly. In addition, storage piles and inactive areas can be covered to reduce wind erosion. Equipment will be decontaminated before leaving the site. Capped areas would be re-vegetated with grass for aesthetics and to minimize erosion. Re-vegetating with native trees, grasses, and wetland plants to be compatible with future land uses would restore the disturbed sites.

Time to Complete: Remedial action would require 2.9 years to complete and would include no O&M period (Table 8.1). Following completion of excavation and restoration, the site soils would be released for unrestricted use. However, the potential groundwater alternative may require land use restrictions.

8.2.2.6 Implementability

Technically and administratively, this alternative is highly implementable. Excavation of impacted soils, construction of temporary roads, and on-site truck transport of soil are conventional activities in construction projects of this kind. Multiple disposal facilities are available that can accept the waste. Construction and operation of the components of Alternative 5 would be straightforward. Resources are readily available for removing soil and standard excavation and construction equipment would be used. Special engineering techniques involving precautions for excavation near buildings and structures also would be observed during remediation. Borrow sites for backfill and soil cover have not been selected, but are anticipated to be locally available.

The acceptability of Alternative 5 would be affected by the administrative requirements for transport and disposal. The DOT regulates the transport of most radioactive and chemically hazardous materials. Some states also have their own additional requirements. Depending upon the types and activities of radioactivity being transported, the material may be subject to such requirements. Consultation with the local Engineer departments would be undertaken to evaluate the impact of the truck traffic on the narrow farm roads that surround the Luckey site.

Careful planning would be needed between remedial action planners and current tenants to minimize disruptions and/or impacts to tenant operations during implementation. Access routes for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be taken to minimize hazards posed to tenant personnel. This type of planning will increase the difficulty of implementability but also will reduce risks to personnel.

8.2.2.7 Cost

The present value cost to complete Alternative 5 (in FY 2002 dollars) is approximately $36.5 million. Costs are based on excavation and off-site disposal of accessible impacted soils. Operation and maintenance costs are zero.

8.2.3 Alternative 6: Excavation of Soils, Treatment, and Off-site Disposal (Soils) ~ Unrestricted Land Use

Alternative 6 includes excavation combined with treatment and off-site disposal to meet media-specific cleanup goals for the subsistence farmer receptor. A number of different contaminants exist in site soils and only the radionuclides are currently expected to be treatable by the selected technology. The remaining soils would be excavated and transported similar to Alternative 5. Contaminated rubble, which may be encountered from some areas of the site, would be crushed or broken up to meet requirements of the receiving facility. Soils containing radionuclides exceeding established ARAR-based cleanup goals would be excavated and treated on site. Treated soils meeting ARARs would be used as backfill. Treated soils and residuals exceeding established ARAR-based cleanup goals would be shipped to a permitted, off-site disposal facility. Excavation, use of road cover, monitoring, short-term containment technologies, and truck and rail transportation are components of this alternative. Under this alternative groundwater is not addressed. A groundwater alternative (Alternatives 7, 8, and 9) would be implemented in conjunction with this alternative to achieve a complete remediation solution.

8.2.3.1 Overall Protection of Human Health and the Environment

Alternative 6 includes excavation and treatment of soil to meet the media-specific cleanup goals. Remedial activities under Alternative 6 would address both non-radiological and radiological contaminants. Removing soils containing contaminants above established media-specific cleanup goals would limit risks to within the CERCLA acceptable cancer risk range and to less than the non-carcinogenic HI of 1. Exposures to lead would be reduced to acceptable levels based on EPA models. In addition, exposure would be below dose-based limits. Therefore, this alternative is protective of human health.

Current (industrial) and future (industrial or subsistence/residential farmer) land uses allow for minimal habitat for ecological receptors and thus minimal exposure. The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit the site.

8.2.3.2 Compliance with ARARs

ARAR-based cleanup goals selected for the Luckey site were detailed under Alternative 1. Under Alternative 6, all ARAR-based cleanup goals would be satisfied.

8.2.3.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of Alternative 6 is similar to Alternative 5. The excavation and removal of impacted soils would result in a permanent reduction in site risks.

Removing soils to achieve established media-specific cleanup goals would be protective of human health under future use scenarios without dependence on land use controls. This alternative is permanent, because all materials that pose an unacceptable health risk would be removed and placed in a permanent disposal facility. Therefore, no long-term management of soils would be required.

Removal of impacted soils would effectively reduce the long-term contamination and potential for re-contamination of groundwater. One of the groundwater alternatives (Alternatives 7, 8, or 9) would address the remediation of groundwater.

8.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Soil treatments, such as soil washing, concentrate the contaminants into a smaller volume. The "clean stream" still contains some low concentrations of residual contamination. The total volume of the clean and concentrated stream is larger than the original volume of impacted soils before processing. Toxicity and mobility could be affected by changing the chemical composition of the constituents in the soil. While soil washing mobilizes constituents in order to remove and concentrate them, once separated, the products of both the clean and concentrated stream are more readily handled. Therefore, the changes to toxicity and mobility would be small. Reduction of the contaminated fraction is estimated for costing purposes to be 50 percent of the throughput.

8.2.3.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 6 is similar to Alternative 5 with the exception of the potential for worker exposure during treatment. The overall risk in implementing this alternative is increased (relative to Alternative 5) because of the handling of wastes during treatment. When performing soil treatment, workers would follow a HASP and wear appropriate PPE to minimize exposures. Mitigation measures would be used to ensure minimization of short-term impacts, such as erosion and dust control during construction.

Remedial action would require three (3) years to complete and would include no O&M period (Table 8.1). Following completion of excavation, treatment, and restoration, the site soils would be released for unrestricted land use. However, the potential groundwater alternative may require land use restrictions.

8.2.3.6 Implementability

Effectiveness and implementation concerns for this alternative include: the ability of the soil treatment process to meet media-specific cleanup goals, logistical and technical problems for pilot demonstrations and scale-up to full-scale operations, local resistance to on-site treatment, demonstrating the achievement of acceptable dose limits when using treatment residuals as backfill.

This alternative is considered to be technically implementable if certain treatment performance criteria can be met. Soil washing technologies are currently available commercially, although site-specific pilot studies will be required prior to remedial action to determine if these technologies could be cost effectively applied to this site. Although it is technically feasible to wash impacted soils, the volume reduction potentially achievable through washing is anticipated to be minimal, based on the geotechnical characteristics of the soils at the Luckey site. Typically, soil washing is most effective if the contaminants of concern are found in one soil fraction (i.e., all the same size) and that fraction is a small percentage of the total soil volume. EPA suggests that an efficiency of 90 percent is ideal (requiring less than 10 percent fines) (EPA 1996b), and USACE indicates the technology is applicable mainly to soils with less than 25 percent clay (USACE 2000b). Most of the soils at the Luckey site contain fines (from

40 to 90 percent silt and clay; from 1 to 64 percent clay) (USACE 2000a). Results from the RI Report indicate only three of 13 samples analyzed for geotechnical properties met the 25 percent or less clay fraction requirement (USACE 2000a). Therefore, technical implementability is a potential concern for this alternative.

Careful planning would be needed between remedial action planners and current tenants to minimize disruptions and/or impacts to tenant operations. Access routes for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be taken to minimize hazards posed to tenant personnel. This type of planning will increase the difficulty of implementability, but also will reduce risks to personnel.

Other aspects of this alternative, such as excavation and truck transport of soil, are conventional activities in construction projects of this kind. Standard excavation and construction equipment would be used to remove contaminated material. Resources are readily available for removing impacted soils and providing backfill over treated soils. Borrow sites, for backfill and soil cover, have not been selected, but are anticipated to be locally available.

The acceptability of Alternative 6 would be affected by the administrative requirements for transport and disposal. The DOT regulates the transport of most radioactive and chemically hazardous materials. Some states also have their own additional requirements. Depending upon the types and activities of radioactivity being transported, the material may be subject to such requirements. Consultation with the local roads departments would be undertaken to evaluate the impact of the truck traffic on the narrow farm roads that surround the Luckey site.

8.2.3.7 Cost

The present value cost to complete Alternative 6 (in FY 2002 dollars) is approximately $42.8 million. Costs are based on excavation, treatment efficiency, and off-site disposal of accessible impacted soils. Operation and maintenance costs are zero.

8.2.4 Alternative 7: Monitored Natural Attenuation (Groundwater) ~ Unrestricted Land Use

Alternative 7 consists of monitored natural attenuation, with source control, as recommended in EPA (1999) guidance. Source control would consist of the implementation of one of the soil alternatives (Alternative 5 or 6), which would eliminate further addition of mass to groundwater at concentrations above ARAR-based cleanup goals. Natural attenuation processes at the Luckey site are expected to reduce contaminant concentrations through the processes of dispersion, diffusion, and sorption. Sorption of the contaminants onto the soil and rock matrix also reduces the contaminants' mobility and bioavailability. Modeling results indicate contaminated groundwater in the upper 20 feet of bedrock attenuates within 40 years. The beryllium concentrations in the sands and gravels are expected to drop significantly after the source is removed based upon the assumption that periodic wetting of source materials results in the observed groundwater contamination. This assumption is based upon modeling results (which indicate that beryllium leaching through soil to groundwater is not a likely source) and observations of elevated beryllium concentrations at seasonally high groundwater levels. The magnitude of the drop in beryllium concentrations after source removal is uncertain. Conservative source terms representing the existing beryllium concentration in groundwater were used in fate and transport modeling. Modeling results predict a reduction in beryllium concentrations to cleanup goals in 150 years for the sands and gravels after source removal. Should significant contamination occur within the clay-rich till, natural attenuation time frames could be much longer.

8.2.4.1 Overall Protection of Human Health and the Environment

Alternative 7 includes installation of monitoring wells to monitor attenuation of beryllium, lead, and uranium in groundwater. Monitored natural attenuation would address both non-radiological and radiological contaminants within the groundwater. The further release of contaminants to the groundwater above groundwater ARAR-based cleanup goals also would be eliminated through source control.

Currently there is no unacceptable exposure to these constituents in groundwater. Only beryllium, which occurs in groundwater at the northern fence line, is predicted to move off site for a period of about 40 years in the upper bedrock and up to approximately 150 years in the sand and gravel. This movement is expected to occur over a distance of less than 300 feet. Groundwater within the overburden is predicted to remain above ARAR-based cleanup goals for beryllium, lead, and uranium in the localized areas where they have been detected. Modeling results predict that although concentrations exceed ARAR-based cleanup goals in the shallow bedrock and overburden, ARAR-based cleanup goals are not exceeded in deeper bedrock where domestic supply wells are generally installed. Until groundwater is returned to a condition of compliance, land use controls would restrict the use of groundwater. Therefore, the alternative would be protective of human health.

8.2.4.2 Compliance with ARARs

ARAR-based cleanup goals selected for the Luckey site were detailed under Alternative 1. Under Alternative 7, all ARAR-based cleanup goals in groundwater would be satisfied. With the addition of one of the soil alternatives all ARAR-based cleanup goals would be satisfied.

8.2.4.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of Alternative 7 is very good. The excavation and removal of impacted soils under one of the soil alternatives would result in a permanent reduction in the risk of recontamination of the groundwater. Natural attenuation would ensure groundwater remediation would be permanent. By removing the source material or preventing additional impacts to groundwater, natural attenuation processes in the groundwater system will eventually reduce concentrations of contaminants below ARAR-based cleanup goals. For purposes of this evaluation, it is assumed the current environmental monitoring program would continue until natural attenuation had resulted in attainment of groundwater clean-up goals. Five-year reviews would be necessary to confirm groundwater ARAR-based cleanup goals have been attained.

8.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under this alternative no actions would be taken to reduce the toxicity, mobility, or volume of contaminants in groundwater. Naturally occurring conditions at the site would act to reduce concentration and mobility. Mobility of the constituents is reduced through the sorption of contaminants onto the clay-rich till and, to a lesser extent, the sands and gravels. Sorption within the bedrock is assumed to be negligible. Concentrations are reduced through the processes of dispersion, diffusion, and sorption as contaminants move through the overburden and the bedrock aquifer.

8.2.4.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 7 is good for groundwater within the bedrock aquifer and could be poor for groundwater within the overburden. This is due to predicted persistence of COCs above ARAR-based cleanup goals, particularly in the event that significant contamination occurs in the clay-rich till. Monitoring, following EPA (1999) guidance, will be used to evaluate short-term effectiveness of MNA with respect to overburden and carbonate bedrock groundwater. Land use controls would be placed to restrict the use of groundwater until monitoring has shown the process to be complete. When performing groundwater sampling, workers would follow a HASP and wear appropriate PPE to minimize exposures. Mitigation measures would be used to ensure minimization of short-term impacts, such as erosion and dust control during construction.

Installation of monitoring wells would require less than ¼ year to complete and could include 150 years of O&M (Table 8.1). As indicated earlier, the beryllium concentrations in the sands and gravels are expected to drop significantly after the source is removed based upon the assumption that periodic wetting of source materials results in the observed groundwater contamination. The 150-year O&M period results from the predicted persistence of beryllium in groundwater within the overburden sands and gravels using conservative source terms representing the existing beryllium concentration in groundwater and is therefore included for use in cost estimates. Time frames could be longer in the event that significant contamination exists within the clay-rich till. Time frames also could be shorter. Following completion of monitoring well installation and implementation of land use controls, monitoring and five-year reviews would be conducted.

8.2.4.6 Implementability

This alternative is considered to be technically implementable. Modeling indicates the groundwater contaminants will naturally attenuate in the bedrock aquifer within a time frame considered reasonable for groundwater and could be reasonable for overburden groundwater. Land use controls restricting groundwater use are considered technically implementable.

Drilling and monitoring of groundwater wells is an established activity and generally does not pose implementation problems. Equipment and personnel are readily available. The wells would be installed to monitor observed occurrences of contaminants in the groundwater and at selected down-gradient locations from probable source areas to demonstrate MNA effectiveness (Figure 7.2). Initially, existing monitoring wells would be used to monitor the effectiveness of MNA. These would be supplemented in instances where monitoring wells no longer exist or require replacement. A long-term monitoring plan would be developed for groundwater sampling and reporting requirements.

The acceptability of Alternative 7 would be affected by the administrative requirements for monitoring and the requirement to restrict groundwater use for a lengthy period of time. Imposition of these controls would depend on the cooperation of the current owner and the State. Many durable land use controls can be placed on the property only by the owner of the property. Other durable land use controls require the involvement of local government to implement, monitor, and maintain the controls. Local government involvement occurs on a voluntary basis. However, in some cases the federal government can acquire a real estate interest in land. All of these factors add to the administrative difficulty of implementing this alternative.

8.2.4.7 Cost

The present value cost to complete Alternative 7 (in FY 2002 dollars) is approximately $0.83 million. Costs are based on installation of monitoring wells. Operation and maintenance costs (for monitoring and land use controls) also are estimated for a period up to 150 years.

8.2.5 Alternative 8: Active Groundwater Treatment – Ex Situ (Groundwater) ~ Unrestricted Land Use

Alternative 8 consists of the installation of a pump and treat system to remove contaminated groundwater from beneath the site and subsequently remove the contaminants via treatment processes. Alternative 8 includes installation of monitoring wells, extraction wells, and a treatment system. Cleanup of contaminated groundwater in the overburden would be completed within 50 to 80 years and within 25 years for contaminated groundwater in the carbonate bedrock based upon predictive modeling results. Time frames for groundwater cleanup could be longer if significant contamination occurs in groundwater within the clay-rich till above the bedrock. Monitoring of groundwater while the treatment system is in operation is included. This alternative would be implemented in conjunction with one of the soil alternatives for a complete remediation solution.

8.2.5.1 Overall Protection of Human Health and the Environment

Remedial activities under Alternative 8 would address both non-radiological and radiological contaminants. Until the groundwater had returned to a condition of compliance, land use controls would restrict the use of groundwater. Therefore, the alternative is protective of human health. The further release of contaminants to the groundwater above ARAR-based cleanup goals in groundwater also would be eliminated through source control.

Currently there is no exposure to these constituents in groundwater. Future off site migration is reduced or eliminated through the operation of the groundwater extraction wells. Until the groundwater is returned to a condition of compliance, land use controls would restrict the use of groundwater. Therefore, the alternative is protective of human health.

8.2.5.2 Compliance with ARARs

ARAR-based cleanup goals selected for the Luckey site were detailed under Alternative 1. Under Alternative 8, all ARAR-based cleanup goals in groundwater would be satisfied. With the addition of one of the soil alternatives, all ARAR-based cleanup goals would be satisfied.

8.2.5.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of Alternative 8 is similar to Alternative 7. The excavation and removal of impacted soils under one of the soil alternatives would result in a permanent reduction in the risk of recontamination of the groundwater. The extraction and treatment of contaminated groundwater would ensure that when land use controls were lifted, the remediation would be permanent. For the purposes of this evalaution, it is assumed that an environmental monitoring program would remain part of the alternative until the treatment resulted in groundwater meeting the clean-up goals. Five-year reviews would be necessary to confirm ARAR-based cleanup goals have been attained.

By removing the source material or preventing additional impacts to groundwater and by treating contaminated groundwater, the pump and treat system will reduce concentrations of contaminants to below ARAR-based cleanup goals in a shorter time frame than natural attenuation in both the bedrock aquifer and the overlying sands and gravels. Contaminants in the clay-rich till would be much more difficult to pump and treat.

Dewatering of the relatively thin zones of groundwater contamination in the overburden could limit the long-term effectiveness. By dewatering the overburden, contaminants would be left behind within the aquifer matrix. Re-saturation of these materials could result in the recontamination of the groundwater after pump and treat operations had ceased.

8.2.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under this alternative groundwater would be treated to remove contaminants and thus reduce their volume and mobility. Off site migration would be reduced or eliminated through the hydraulic control (groundwater capture zones) produced by the operation of the extraction wells. Extracted groundwater would be piped to an on-site treatment facility where materials such as activated alumina and activated carbon would be used to remove the beryllium, lead, and uranium from the groundwater.

8.2.5.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 8 is good for contaminated groundwater within the carbonate bedrock, but less effective for the overburden materials. Time frames for the remediation of the sands and gravels are roughly one half the time required for the natural attenuation of these materials (50 to 80 years for pump and treat versus 150 years for MNA).

Beryllium remains in the bedrock aquifer for approximately 25 years under pump and treat at one location based upon the current modeling efforts. Land use controls would be placed to restrict the use of groundwater until monitoring has shown the process to be complete. When performing groundwater sampling or servicing the equipment, workers would follow a HASP and wear appropriate PPE to minimize exposures. Mitigation measures would be used to ensure minimization of short-term impacts, such as erosion and dust control during construction and risks associated with treatment system operation (such as accidents/potential releases).

System design and installation would require 1½ year to complete. An 80 year O&M period (Table 8.1) also is included. Following completion of monitoring well installation, and implementation of land use controls for the site property, monitoring and five-year reviews would be conducted.

8.2.5.6 Implementability

Effectiveness of this alternative will be governed by the ability to pump sufficient groundwater to reduce concentrations in the thin zones of contamination without dewatering the soil. The overburden materials at the site contain a thin zone of saturation. Modeling results indicate that pumping from within or below these materials can quickly dewater them. With no water moving through the materials, the constituents remain in place until becoming re-saturated. Modeling results indicate pumping of contaminants from the upper 20 feet of the bedrock aquifer is effective within a reasonable time frame.

This alternative is considered to be technically implementable. Pump and treat systems are a common technology and the anticipated treatment media are available. Drilling and monitoring of groundwater wells is an established activity and does not pose implementation problems. Equipment and personnel are readily available. Land use controls restricting groundwater use are considered technically implementable.

Careful planning would be needed between remedial action planners and current tenants to minimize disruptions and/or impacts to tenant operations. Access routes for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be taken to minimize hazards posed to tenant personnel. This type of planning will increase the difficulty of implementability but also will reduce risks to personnel.

The acceptability of Alternative 8 would be affected by the administrative requirements for monitoring and the requirement to restrict groundwater use for a lengthy period of time. The acceptability also could be affected by the necessity of maintaining a treatment system for an extended period of time. Imposition of these controls and continuation of the treatment program would depend on the cooperation of the current owner and the State. Many durable land use controls can be placed on the property only by the owner of the property. Other durable land use controls require the involvement of local government to implement, monitor, and maintain the controls. Local government involvement occurs on a voluntary basis. However, in some cases the federal government can acquire a real estate interest in land. All of these factors add to the administrative difficulty of implementing this alternative.

8.2.5.7 Cost

The present value cost to complete Alternative 8 (in FY 2002 dollars) is approximately $3.7 million. Costs are based on installation of six extraction wells and 12 monitoring wells. Operation and maintenance costs (for monitoring and land use controls) are estimated for an 80 year period.

8.2.6 Alternative 9: Electrokinetics (Groundwater) ~ Unrestricted Land Use

Alternative 9 includes the installation of approximately 650 electrode wells in each area of shallow contaminated groundwater in the unconsolidated materials overlying the carbonate bedrock (i.e., in the region encompassing wells MW-02(S) and MW-26(S), and in the area encompassing well MW-24(S)). The electrode wells will consist of 4-inch PVC well casing, screened over the entire depth of the groundwater between the water table and bedrock. Electrodes wrapped in permeable membranes containing electrolyte are lowered into the groundwater. The electrodes are designed to be as long as the screened interval. The electrodes are wired in alternating rows of cathodes and anodes, which create an electrical field that drives metal contaminants to one set of wells (the anodes). At the anodes, the metal contaminants cross the permeable membrane and remain inside the membrane until the electrolyte is removed, either by pumping or by removal of the electrode once ARAR-based cleanup goals have been reached. To support electrolyte replacement, a network of pipes and acid replenishment tanks would be plumbed to the electrodes. Monitoring of groundwater while the treatment system is in operation is included. This alternative would be implemented in conjunction with one of the soil alternatives for a complete remediation solution.

For purposes of this evaluation, it is assumed that the well spacing between electrodes will be 3 meters and that the total electrokinetic treatment time will be 15 years for the unconsolidated materials overlying the carbonate bedrock. To minimize the total cost of remediation, it is further assumed that the beryllium-contaminated groundwater will be treated first, and the electrodes will be reused to treat the uranium-contaminated groundwater. The presumed number of wells, their spacing, and treatment times for each area of the site are based on engineering judgment consistent with previous applications of the technology. This will provide for cost-effective removal of metal contaminants from the groundwater at the Luckey site. Decreasing the spacing between electrodes would increase capital costs, but reduce operating costs. Increasing the power would reduce treatment time, but increase the cost of the remedial alternative. A pilot-scale field study would be necessary to optimize the numbers of electrodes, their spacing, and treatment time. Because groundwater in the carbonate bedrock may not be treated with electrokinetics, up to 25 years of monitoring may be required after completion of the electrokinetic remedy (40 years for natural attenuation in carbonate bedrock less the 15 years over which electrokinetics is applied).

8.2.6.1 Overall Protection of Human Health and the Environment

Remedial activities under Alternative 9 would address both non-radiological and radiological contaminants by driving them to the anodes in the groundwater for collection and subsequent removal. This alternative is analogous to established plating and chlor-alkalai industry technologies. Under the influence of the electric field generated by the electrodes, metal contaminants will migrate to the anodes and will concentrate in the electrolyte surrounding the anodes.

Because this alternative results in the removal of metal contaminants from the groundwater, ARAR-based cleanup goals are attained and this alternative is protective of human health. This alternative also minimizes short-term risks to human health because it is an in situ process; thereby not requiring excavation activities. In addition, until the groundwater is returned to a condition of compliance, land use controls would restrict the use of groundwater.

8.2.6.2 Compliance with ARARs

ARAR-based cleanup goals selected for the Luckey site were detailed under Alternative 1. Under Alternative 9, all ARAR-based groundwater cleanup goals would be satisfied because the contaminants would be removed. Used in combination with one of the soil alternatives, all ARAR-based cleanup goals would be satisfied for the site.

8.2.6.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of Alternative 9 is similar to Alternative 8. The excavation and removal of impacted soils under one of the soil alternatives would result in a permanent reduction in the risk of recontamination of the groundwater. Furthermore, the removal and treatment of contaminants in the groundwater would ensure that, when land use controls were lifted, the remediation would be permanent. For purposes of this evaluation, it is assumed that an environmental monitoring program would remain as part of this alternative until the treatment had resulted in groundwater meeting the clean-up goals. Five-year reviews would be necessary to confirm that ARAR-based cleanup goals had been attained.

By removing the source material or preventing additional impacts to groundwater, recontamination of the groundwater would be precluded. The electrokinetic system will remove contaminants from the groundwater, reducing concentrations of contaminants to below the ARAR-based cleanup goals in a shorter time frame than either natural attenuation or pump and treat methods. Additionally, electrokinetics is ideally suited for mobilizing and collecting metal contaminants in tight groundwater formations of low flow or hydraulic conductivity similar to the Luckey site.

8.2.6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under this alternative, the toxicity, mobility, and volume of contamination would all be reduced through treatment. This alternative consists of contaminant removal and treatment. Toxicity would be reduced as concentrations of contaminants decrease below ARAR-based cleanup goals. Similarly, contaminant mobility and volume would be reduced through removal from the groundwater.

8.2.6.5 Short-Term Effectiveness

The short-term effectiveness of Alternative 9 is good. Contaminants would migrate to and be collected at the anodes the entire time the treatment system was in operation. Correspondingly, groundwater concentrations would steadily decline. The envisioned treatment time was predicated on minimizing remedial costs. Decreasing treatment times could increase the short-term effectiveness; however, that would increase operating and remediation costs.

Land use controls would be placed to restrict the use of groundwater until monitoring had shown the process to be complete. When performing groundwater sampling or servicing the equipment, workers would follow a HASP and wear appropriate PPE to minimize exposures. Mitigation measures would be used to ensure minimization of short-term impacts such as erosion and dust control during construction and risks associated with system operation (such as accidents/potential releases).

Remedial action would require one (1) year to complete and would include a 40-year O&M period (Table 8.1). Following completion of monitoring well installation and implementation of land use controls for the site property, monitoring and five-year reviews would be conducted.

8.2.6.6 Implementability

Effectiveness and implementation concerns for this alternative include the ability to maintain the current flow through the electrodes at the proper levels and the ability to replenish electrolyte as it becomes saturated. However, at concentrations of contaminants found in groundwater at the Luckey site, electrolyte saturation is not anticipated. In addition, operating parameters are monitored and controlled remotely through a computer processor.

This alternative is considered to be technically implementable. Electrokinetic systems are a relatively new technology, but are based on well-established electrochemical industry processes. Electrokinetic systems are ideally suited for and have worked well in tight formations like those at the Luckey site. Land use controls restricting groundwater use are considered technically implementable. Drilling and monitoring of groundwater wells is a well-established activity and does not pose implementation problems. Equipment and trained personnel are readily available.

Careful planning would be needed between remedial action planners and current tenants to minimize disruptions and/or impacts to tenant operations. Access for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be taken to minimize hazards posed to tenant personnel. This type of planning will increase the difficulty of implementability but also will reduce risks to personnel.

The acceptability of Alternative 9 would be affected by the administrative requirements for monitoring and the requirement to restrict groundwater use for a lengthy period of time. The acceptability also could be affected by the necessity of maintaining a treatment system, which involves the use of considerable electrical energy. Imposition of these controls and continuation of the treatment program would entail cooperation of both the current owner and the State.

8.2.6.7 Cost

The present value cost to complete Alternative 9 (in FY 2002 dollars) is approximately $9.4 million. Costs are based on installation of monitoring wells and electrodes. Operation and maintenance costs (for monitoring and land use controls) are estimated for a 40-year period.

8.3 CONSIDERATIONS COMMON TO ALL ALTERNATIVES

8.3.1 Monitoring and Mitigative Measures

A mitigation action plan would be developed during remedial design to specify measures that would be taken during implementation of the remedial action to minimize risk to human health and the environment (e.g., environmental controls and contingency response actions). The primary monitoring and mitigative measures that would be used at the Luckey site are described below. These measures would be effective in minimizing the potential adverse effects associated with implementation of the alternatives.

Construction Activities: Construction practices to control potential releases to the environment would include management and engineering practices. Hay bales and silt fences would be used to prevent soil transport in surface water runoff. Wetting surface materials with water or dust control chemicals would mitigate fugitive dust impacts. Regular surface wetting can reduce the dust loads from construction sites and storage piles by as much as 50 percent. Chemical wetting agents also can increase the reduction significantly. In addition, storage piles and inactive areas can be covered to reduce wind erosion. Equipment will be decontaminated before leaving the site. Re-vegetating with native trees, grasses, and wetland plants, to be compatible with future land uses, would restore the disturbed sites. Groundwater, surface water, air, and sediment monitoring would be conducted. Habitat would be restored and mufflers and barriers would be used for noise abatement.

Transportation: Wastes would be containerized and fitted with a cover and/or liner during long distance transport across public roads. The conveyance equipment could be fitted with a cover and/or lined with a barrier. Vehicles would be decontaminated and inspected before leaving contaminated areas.

Worker Protection: Activities would be conducted in accordance with approved health and safety plans. PPE, personal monitoring devices, and decontamination procedures would be used to minimize exposure to and the spread of contamination. The potential for worker exposure is mitigated through these measures. Personal monitoring devices and a medical monitoring program would be used to ensure workers do not receive exposures that would result in adverse health effects.

Protection of the General Public: A network of ambient air monitors would be installed to measure dust emissions during construction activities. Mitigation measures, such as wetting soil, will be implemented if emissions exceed levels that could pose a risk to human health. Access controls also would be used to restrict public access to construction areas

Environmental Restoration: Any portions of the on-site wetlands impacted by remedial actions will be restored to their pre-construction condition. No actions will occur in the floodplain of Toussaint Creek as part of the alternatives outlined in this PP.

8.3.2 Impact of Potential Loss of Land Use Controls

For Alternative 1, land use controls would not be maintained, so there would be no impact if land use controls fail. However, for Alternative 1, changes in land use could result in the release of contaminants and cause potential future impacts on human health and the environment in the long term. In Alternatives 5 and 6, the soil contamination is removed to unrestricted land use cleanup goals. Land use controls are not necessary in conjunction with Alternatives 5 and 6. If MNA is selected as the remedial measure for groundwater, for Alternatives 5 and 6, then there is a slight potential for exposure to contaminated groundwater on site and to beryllium off site if land use controls fail during the remedial measure. Alternatives 7, 8, and 9 rely on the use of land use controls to control groundwater use for periods ranging from 40 to possibly as much as 1,000 years, but a period from 40 up to 150 years is the expected duration of land use controls. Should these controls fail, only wells deriving their water solely from the overburden would present a risk. Wells completed in the bedrock at depths (50 to 80 feet into the bedrock), typical for most domestic wells in the area, should continue to meet groundwater cleanup goals.

8.3.3 Short-term Uses and Long-term Productivity

Implementation of any set of alternatives would require the use of the Luckey site to support cleanup activities and the use of depletable resources, such as construction materials, fuel, and petroleum-based products. Alternatives that include excavation and disposal would require the long-term commitment of land for waste disposal either on site or at an off-site facility or facilities.

The short-term use of the site for remedial activities could adversely affect tenant operations. Planning will be done before implementation of any alternative to reduce risks to the current tenants and impact to operations. The long-term effect on the current tenants also was taken into account when analyzing each alternative. Alternative 1 could make transfer of the property from one owner to another more difficult while Alternatives 5 and 6 could facilitate such a transfer. Alternatives 7, 8, or 9 may increase the difficulty of transferring property since monitoring and treatment would be required.

The impact of the remediation on the local economy could be fairly significant. An outside contractor would be performing the work. Therefore, mostly secondary jobs would be impacted. Few local residents would be hired directly by the remediation contractors. However, the remediation workers would be spending money in the local economy for the duration of the remediation.

8.3.4 Final Status Surveys

Cleanup goals are used to provide a basis for comparison of alternatives. They are not to exceed concentrations to generate a potentially conservative volume estimate. For the chemical COCs, during implementation of the selected remedial alternative (including confirmatory sampling), cleanup goals will be used as target concentrations (e.g., 95% upper confidence limit of the mean) for the final COCs so no "hot spots" remain, potentially posing unacceptable risk. Presentation of the chemical cleanup confirmation methodology will occur in the detailed design document following approval of this Proposed Plan. For radionuclides, MARSSIM will be applied and is summarized.

USACE intends to use MARSSIM (DoD 2000) to ensure exposure to all radiological contaminants combined will not exceed dose-based limits. MARSSIM provides a consistent and scientifically rigorous approach for demonstrating compliance with dose-based limits, such as the 25 mrem/yr limit used at the Luckey site. The approach includes the development of surveying and sampling criteria for the final site investigation prior to release (called the "final status survey"). It considers COC concentrations averaged over entire exposure units or limited to small areas of elevated activity. A final status survey plan based on the MARSSIM methodology will be developed and implemented to assure that current or potential future doses are acceptable (as defined by the restrictions of remedial alternative).

MARSSIM is specifically designed for use with radionuclides and will not be applied to chemical contaminants. The specific list of radiological contaminants to be considered in the MARSSIM plan includes radium-226, thorium-230, uranium-234, and uranium-238. The corresponding dose-based cleanup goals are defined by MARSSIM as the derived concentration guideline level (DCGL). A DCGL applied over entire exposure units also is known as the $DCGL_W$, (The "W" subscript stands for the Wilcoxon Rank Sum test, which is the statisitcal test recommended in MARSSIM for demonstrating compliance when the contaminant is present in background.) it is based on an average concentration over a large area and is used in statistical testing per MARSSIM. Small areas of elevated activity are evaluated through an elevated measurement comparison (EMC) and the associated DCLG is called the $DCGL_{EMC}$. In general, the EMC considers the following:

1. The relationship between dose and the physical size of an area of elevated activity – area factors are used to account for this relationship (area and dose are proportional for a fixed concentration, but the specific relationship must be defined) and
2. The ability to scan for radiological contaminants – surveying and sampling requirements may become more stringent if radiological contaminants can not be readily scanned.

In conclusion, the use of MARSSIM will assure that for each applicable alternative (i.e., Alternative 1 by definition will not include MARSSIM evaluations), radiological doses will be acceptable whether averaging across entire exposure units or considering small areas of elevated activity. In other words, soil concentrations of radium-226, thorium-230, uranium-234, and uranium-238 will be shown through a MARSSIM evaluation to be below the $DCGL_w$ and $DCGL_{EMC,}$ corresponding to each applicable remedial alternative.

8.3.5 Considerations Common to Groundwater Alternatives

In addition to the items noted above, there are a number of considerations common to each of the groundwater alternatives. These considerations include the following:

- The preferred groundwater alternative will be implemented in conjunction with one of the soils alternatives (i.e., Alternative 5 or 6). Alternatives 5 and 6 remove the potential for further groundwater impacts.
- The clay-rich tills have the potential to retain beryllium, lead, and uranium through sorption for long periods of time. If this sorption process is reversible, contamination in groundwater within the clay-rich tills could remain above ARARs for long periods of time (hundreds of years). These materials also may act as a source of contamination to sand and gravel or underlying carbonate bedrock aquifer and result in increased time frames for attainment of ARARs.
- Groundwater sampling results indicate decreasing trends in uranium and, to a lesser extent, lead concentrations, suggesting MNA may be an effective alternative.
- Recently observed variations in contaminant concentrations (from June 2001 and November 2001) may be indicative of seasonal fluctuations in beryllium, lead, and uranium concentrations or the result of direct contact between contaminant sources (base of trenches and Lagoon B).

Table 8.1. Estimated Completion Time Frames for Alternatives

Alternative	Remedial Design (years)	Remedial Action (RA) (years)	Post RA Documentation (years)	O & M Period (years)
Alternative 1: No Action (Soils and Groundwater)	0	0	0	0
Alternative 5: Excavation of Soils and Off-site Disposal (Soils) ~ Unrestricted Land Use	1	2.9	1	0
Alternative 6: Excavation of Soils, Treatment, and Off-site Disposal (Soils) ~ Unrestricted Land Use	2	3	1	0
Alternative 7: Monitored Natural Attenuation (Groundwater) ~ Unrestricted Land Use	0.5	0	1	40 to 150
Alternative 8: Active Groundwater Treatment (Groundwater) ~ Unrestricted Land Use	1	0.5	1	80
Alternative 9: Electrokinetics (Groundwater) ~ Unrestricted Land Use	1	1	1	40

Table 8.2 Summary of Detailed Analysis of Remedial Alternatives

NCP Evaluation Criteria	Alternative 1 No Action (Section 8.2.1)	Alternative 5 Excavation and Off-site Disposal (Unrestricted Land Use) (Section 8.2.2)	Alternative 6 Excavation, Treatment, and Off-site Disposal (Unrestricted Land Use) (Section 8.2.3)	Alternative 7 Monitored Natural Attenuation (Unrestricted Land Use) (Section 8.2.4)	Alternative 8 Active Groundwater Treatment (Unrestricted Land Use) (Section 8.2.5)	Alternative 9 Electrokinetics (Unrestricted Land Use) (Section 8.2.6)
(1) OVERALL PROTECTIVENESS						
Human Health Protection	Not protective due to risk from exposure.	Protective due to removal of impacted soils from site.	See Alternative 5.	Protective due to natural attenuation and mitigation of exposure pathways due to land use controls.	Protective due to treatment of groundwater and land use controls.	See Alternative 8.
Environmental Protection	Continued potential for adverse impacts from existing conditions; however, habitat and receptors are limited.	Action designed to address human health risks; however, this also will reduce risks to ecological receptors due to removal of impacted soils from site.	See Alternative 5.	Groundwater is not an ecological concern until it becomes surface water.	See Alternative 7.	See Alternative 7.
(2) COMPLIANCE WITH ARARs						
ARARs	Not compliant.	Compliant.	Compliant.	Compliant in approximately 40 to 150 years.	Compliant in approximately 80 years.	Compliant in approximately 40 years.
(3) LONG-TERM EFFECTIVENESS AND PERMANENCE						
Magnitude of Residual Risk	Residual risk exceeds EPA risk range due to waste remaining in current configurations, thereby allowing for potential future exposure.	Meets risk range without restrictions on future land use. Less residual risk than Alternative 1.	See Alternative 5.	Meets risk range without restrictions. Would require a longer time frame to achieve than Alts 8 or 9.	Meets risk range without restrictions on future land use.	See Alternative 8.
Adequacy and Reliability of Controls	No land use controls.	No land use controls required.	See Alternative 5.	Land use controls required and considered adequate while MNA works.	Land use controls required and considered adequate for duration of treatment.	Land use controls required and considered adequate for duration of treatment.
Long-Term Management	No long-term management.	Not required.	See Alternative 5.	Required for up to 150 years or duration of treatment.	Required for 80 years.	Required for 40 years.
(4) REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT						
Reduction through Treatment.	None (no treatment).	None.	Volume reduction.	None.	Volume and mobility reduction.	See Alternative 8.
(5) SHORT-TERM EFFECTIVENESS						
Community	Risk to community not increased, but potential contaminant migration and increased exposure over time.	Slight potential for an increase in risk from construction activities. Site risks would be controlled by mitigation measures. Transportation risks introduced with off-site disposal.	See Alternative 5. Potential increase in risk due to additional materials handling during treatment. Site safety measures would be implemented to control risks.	Slight potential for an increase in risk during well installation activities. Site risks would be controlled by mitigation measures.	Slight potential for an increase in risk during well installation activities. Site risks would be controlled by mitigation measures.	Potential for an increase in risk from construction and implementation activities. Site risks would be controlled by mitigation measures.

Table 8.2 Summary of Detailed Analysis of Remedial Alternatives

NCP Evaluation Criteria	Alternative 1 No Action (Section 8.2.1)	Alternative 5 Excavation and Off-site Disposal (Unrestricted Land Use) (Section 8.2.2)	Alternative 6 Excavation, Treatment, and Off-site Disposal (Unrestricted Land Use) (Section 8.2.3)	Alternative 7 Monitored Natural Attenuation (Unrestricted Land Use) (Section 8.2.4)	Alternative 8 Active Groundwater Treatment (Unrestricted Land Use) (Section 8.2.5)	Alternative 9 Electrokinetics (Unrestricted Land Use) (Section 8.2.6)
Workers	No significant increase of risks or hazards to workers.	Radiological risks and non-radiological hazards reduced by mitigation measures. Site safety measures would be implemented.	See Alternative 5. Potential for additional risks due to materials handling during treatment. Site safety measures would be implemented.	Slight potential of radiological and non-radiological hazards reduced by mitigation measures.	See Alternative 6. Potential for additional risks due to materials handling during treatment. Site safety measures would be implemented.	See Alternative 6. Potential for additional risks due to materials handling during treatment and electrical system needed for electrodes. Site safety measures would be implemented.
Ecological Resources	Continued potential for impacts from existing conditions.	Potential short-term environmental impacts minimized by Engineering controls.	See Alternative 5.	Slight impact.	See Alternative 7.	Potential short-term environmental impacts minimized by Engineering controls.
Engineering Controls	None.	Potential releases controlled with management and engineering practices.	See Alternative 5.	See Alternative 5.	See Alternative 5.	See Alternative 5.
Time to Complete[1]	0 years	2.9 years	3 years	0 years	0.5 years	1 year
O & M Period	0 years	0 years	0 years	40 to 150 years	80 years	40 years
(6) IMPLEMENTABILITY						
Technical Feasibility	Not applicable.	Relatively easy. Readily available technology.	Moderate. Treatment units available commercially, but effectiveness must be demonstrated.	See Alternative 5.	See Alternative 5.	See Alternative 6.
Administrative Feasibility	Not applicable.	Relatively easy.	Would require meeting substantive requirements for placing "clean" soils back on site.	See Alternative 5.	See Alternative 5.	See Alternative 5.
(7) COST						
Estimated cost[2]	$0.0 million	$36.5 million	$42.8 million	$0.83 million	$3.7 million	$9.4 million.
Cost with Alt 7	Not applicable.	$37.3 million	$43.6 million	Not applicable.	Not applicable.	Not applicable.
Cost with Alt 8	Not applicable.	$40.2 million	$46.5 million	Not applicable.	Not applicable.	Not applicable.
Cost with Alt 9	Not applicable.	$45.9 million	$52.2 million	Not applicable.	Not applicable.	Not applicable.

[1] Time to complete remedial action after completion of remedial design, assuming timely project funding. Does not include O & M period.

[2] Estimated costs calculated as net present value in FY 02 dollars using a seven percent discount factor.

9.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

In this section, the alternatives undergo a comparative analysis for the purpose of identifying relative advantages and disadvantages of each on the basis of the detailed analysis above. The comparative analysis provides a means by which remedial alternatives can be directly compared to one another with respect to common criteria. Overall protection and compliance with ARARs are threshold criteria that must be met by any alternative for it to be eligible for selection. The other criteria, consisting of short- and long-term effectiveness; reduction of contaminant toxicity, mobility, or volume through treatment; ease of implementation; and cost are the primary balancing criteria used to select a preferred remedy among alternatives satisfying the threshold criteria. A summary table illustrating the comparative analysis is provided as Table 9.1. Community and state acceptance criteria are preliminarily assessed in Table 9.1 and will be fully addressed after the public comment period.

Additional information pertaining to the advantages and disadvantages of each groundwater alternative are included in Table 9.2. Table 9.3 provides a summary of the predicted or expected timelines specific to the groundwater alternatives. Time frames are estimated during non-pumping and pumping conditions (i.e., while the East Production is simulated to be "off" as well as "on.") Generally, the model indicates operation of the East Production Well shortens the time frame required to achieve cleanup goals in groundwater. It is important to note, the predicted time frames utilizing the groundwater model summarized in Table 9.3 assist in the comparison of alternatives. As with any modeling effort, uncertainty associated with input parameters, historical site operations, and contaminant distributions exist. Therefore, the estimated time frames presented in Table 9.3 for the selected remedies are likely to occur within a period of time similar to the time frame predicted by the groundwater model but not necessarily at the "exact" year.

9.1 COMPARISON USING NCP CRITERIA

9.1.1 Overall Protection of Human Health and the Environment

Each of the alternatives, except Alternative 1, is protective of human health and the environment. The degree of protection and the permanence of this protectiveness is a function of whether and to what extent the alternative utilizes removal or land use control strategies. Alternative 1 is not considered protective for the long term because the BRA predicted risks above the CERCLA acceptable range of 10^{-4} to 10^{-6} are possible if existing controls are not maintained and additional actions are not taken at the site. The excavation and off-site disposal alternatives (Alternatives 5 and 6), when coupled with a groundwater alternative, rank highest in overall protection of human health and the environment because materials above media-specific cleanup goals (for industrial land use or unrestricted land use) are excavated and shipped off-site for disposal.

For Alternatives 5 and 6, a mitigation action plan would be developed during remedial design to specify measures that would be taken during implementation of the remedial action to minimize risk to human health and the environment (e.g., environmental controls and contingency response actions).

Alternative 7, 8, or 9, when coupled with one of the soil remedial alternatives, is protective of human health and the environment. Alternative 7 is expected to achieve ARARs within 40 to 150 years, Alternative 8 within 80 years, and Alternative 9 within 40 years after implementation. The major differences are the time frame in which land use controls are no longer necessary.

9.1.2 Compliance with ARARs

A summary of the proposed ARARs is presented under the ARARs discussion for Alternative 1 (Section 8.2.1.2). Alternatives 5 and 6 satisfy all ARAR-based cleanup goals in soils. Alternatives 7, 8, and 9 satisfy all ARAR-based groundwater clean up goals when implemented in conjunction with one of the soil remedial alternatives. However, the time frame to achieve compliance may be as long as 40 to 150 years for Alternative 7. Alternative 1 does not achieve media-specific cleanup goals established by the ARARs.

9.1.3 Long-Term Effectiveness and Permanence

Human health risks remaining after remediation give an indication of the long-term effectiveness of an alternative. Human health risks due to exposure to contaminated materials will be reduced from the existing levels of risk by varying degrees, depending on the extent of remediation provided by the alternatives.

Alternative 5 or 6, in conjunction with one of the groundwater alternatives, provide the greatest long-term effectiveness because they would remove, for permanent off-site disposal, all soils above unrestricted land use cleanup goals. Alternative 1 would not be effective in the long term, since the contaminated materials would remain and would not be controlled. All of the groundwater alternatives provide long-term effectiveness when coupled with one of the soil remedial alternatives.

Pursuant to CERCLA, site remedy reviews would be conducted every five years for alternatives where contaminants (i.e., soil and groundwater) would remain on site above media-specific cleanup goals (except for the no action alternative). Because concentrations of some contaminants remain on site above the media-specific cleanup goals under Alternative 1, a review would be conducted at least once every five years. These reviews would not be necessary for Alternatives 5 and 6 since verification sampling would be performed at the time of remedy implementation showing that impacted soils above unrestricted land use cleanup goals were removed. Groundwater remediation will necessitate five-year reviews in Alternatives 7, 8, and 9 until the contaminants have attenuated to a concentration allowing unlimited use and unrestricted exposure.

9.1.4 Reduction in Contaminant Volume, Toxicity, and Mobility through Treatment

Alternative 6 is the only alternative that incorporates treatment of soils, and would effect a reduction in contaminant volume. This reduction is estimated for costing purposes to be 50 percent of the throughput. Alternatives 8 and 9 reduce the volume of the contaminated groundwater through treatment. The contaminants would be trapped in a solid matrix or solidified so that their mobility also is reduced.

9.1.5 Short-Term Effectiveness

The biggest difference in short-term effectiveness is due to the potential for accidents from the excavation and transportation of soil. Increased potential for exposure to contaminated media also increases under soil and groundwater treatment scenarios. Under Alternatives 5 and 6, short-term risks due to accidents for workers and the public are increased because of the excavation and off-site transportation involved. Under Alternative 6, there are additional short-term risks due to the treatment of soil. Short-term risks also are increased for Alternatives 5 and 6, if treatment of groundwater (Alternative 8 or 9) is implemented. Alternatives 7, 8, and 9 involve increasing risk to workers due to activities necessary to the alternative. These increased risks are due to well drilling installation of system piping and a filtration system, installation of power systems (including a 480 volt ground level system for

Alternative 9), and handling of filter media and electrolytes. Among the groundwater alternatives, short-term risks are greatest for Alternative 9 and least for Alternative 7.

Short-term negative impacts to the environment are likely to occur with soil excavation considered as part of Alternatives 5 and 6. These impacts also are likely with the groundwater alternatives due to the drilling of monitoring and extraction wells and the construction of treatment facilities. Excavation potentially destroy animals and plants at the excavated locations and existing features of the environment that may provide habitat or food to plants and animals. The degree of short-term damage to the environment increases with the amount of surface area subjected to disturbance.

9.1.6 Implementability

This criterion addresses the ability to technically accomplish the remedy; the ability to obtain approvals and coordinate with other authorities (i.e., administrative feasibility); and the availability of materials and services required for the cleanup. Materials and services for removal of contamination and environmental monitoring activities for the various alternatives are readily available. The degree of difficulty in implementing alternatives increases with the amount and type (i.e., accessible soils) of impacted soils to be excavated, the level of the design/transportation required to dispose of soils in accordance with regulations, and the time/coordination involved in completing the alternative.

All action alternatives are considered implementable on a technical and an availability-of-services basis. Alternatives 5 and 6 involve excavation and off-site disposal, and also use readily available technology and equipment. Alternative 6 also is considered implementable, although it involves greater uncertainties with respect to treatment performance. The proposed soil treatment process is available from commercial sources, and has been effectively demonstrated in other applications. The same is true for all groundwater treatment technologies considered under Alternatives 7, 8, and 9. Alternative 9 requires treatment units that are commercially available, but whose effectiveness has not been demonstrated. Alternative 9 is therefore considered moderately technically feasible. All the groundwater alternatives rely, to some extent, on land use controls. The implementability of these controls is proportional to the duration. Long durations of control will be more difficult to implement.

Alternatives 5 and 6 are most easily implemented on an administrative basis. These alternatives forgo the need to meet substantive disposal permit requirements and land use controls for soil remediated areas. Alternatives 7 and 8 would be difficult to implement administratively due to the long time frames involved.

9.1.7 Cost

The estimated present value cost (in FY 2002 dollars with a seven percent discount factor) to complete each of the alternatives is as follows:

- Alternative 1: $ 0.0 million
- Alternative 5: $36.5 million
- Alternative 6: $42.8 million
- Alternative 7: $ 0.83 million
- Alternative 8: $ 3.7 million
- Alternative 9: $ 9.4 million

Table 9.1 Summary of Comparative Analysis of Remedial Alternatives

NCP Evaluation Criteria	Alternative 1 No Action (Section 8.2.1)	Alternative 5 Excavation and Off-site Disposal (Unrestricted Land Use) (Section 8.2.2)	Alternative 6 Excavation, Treatment, and Off-site Disposal (Unrestricted Land Use) (Section 8.2.3)	Alternative 7 Monitored Natural Attenuation (Unrestricted Land Use) (Section 8.2.4)	Alternative 8 Active Groundwater Treatment (Unrestricted Land Use) (Section 8.2.5)	Alternative 9 Electrokinetics (Unrestricted Land Use) (Section 8.2.6)
(1) Overall Protection of Human Health and the Environment (8.4.1.1)	Low	High	High	Low / Medium	High	High
(2) Compliance with ARARs (8.4.1.2)	Low	High	High	Low / Medium	High	High
(3) Long-Term Effectiveness and Permanence	Low	High	High	Medium	High	High
(4) Reduction of Toxicity, Mobility, or Volume through Treatment (8.4.1.4)	Low	Low	Medium	Medium	High	High
(5) Short-Term Effectiveness (includes potential for environmental impacts) (8.4.1.5) Time to complete[1] O&M Period.	Low 0 years 0 years	Medium 2.9 years 0 years	Medium 3 years 0 years	High 0 years 40 to 150 years	Medium 0.5 years 80 years	Low 1 year 40 years
(6) Implementability (8.4.1.6)	High	High	Medium	High	Medium	Medium
(7) Cost[2] (8.4.1.7)	$0	$36.5 million	$42.8 million	$0.83 million	$3.7 million	$9.4 million
Preliminary Evaluation of Regulatory and Public Input						
(8) State / Agency Acceptance	Low	High	High	Low	Medium	High
(9) Community Acceptance	Low	High	Medium	Low	Medium	High

[1] Time to complete remedial action after remedial design, is dependent upon timely project funding. Does not include O & M.
[2] Estimated costs calculated as net present value in FY 02 dollars using a seven percent discount factor.

Table 9.2. Advantages/Disadvantages of Groundwater Alternatives for Comparative Analysis

Alternative	Advantages	Disadvantages
Alternative 7: Monitored Natural Attenuation	• Observed data for uranium and to lesser extent lead suggest decreasing trends suggesting already effective • Predicted times: lead < 5 yrs; uranium < 30 yrs; beryllium < 40 for bedrock, <150 for sand & gravel • Applies to all areas of the site • Small or negligible volume of Investigative Derived Waste (IDW) • Lower overall costs	• Contamination in clay-rich tills could increase time frame for effectiveness • Requires extensive performance monitoring program • Potential for contaminant migration • Relatively long time period for beryllium in sand and gravel (long-term monitoring) • Public perception as "no action" alternative for groundwater • Land use controls required until attainment of beneficial reuse status (until all ARARs are met)
Alternative 8: Active Groundwater Treatment – Ex situ	• Effective for remediation of groundwater in sand and gravel and carbonate bedrock aquifer • Time to achieve ARARs is predicted to be maximum of 50 to 80 years • Predicted times: lead < 1 year; uranium < 10 years; beryllium <25 years for bedrock < 80 years for sand & gravel • Controls/eliminates potential for contaminant migration to receptors • Reduces contaminant mass/concentration in the groundwater	• Ineffective for contamination in clay-rich tills • Flow field variability from operation or shut down of the East Production Well impacts extraction well placement • Relatively small cone of influence due to shallow contamination (thin zone for pump and treat) may require closer well spacing • System installation and maintenance costs are relatively high • Construction and operation of treatment facility that may require maintenance beyond typical design life • Time period for completion up to 80 years • Generates large volumes of water to be treated and disposed • Possible recontamination after system shutdown • Land use controls required until attainment of beneficial reuse status (until all ARARs are met)
Alternative 9: Electrokinetics	• Addresses contaminated groundwater within the clay-rich till and sand and gravels • Controls or eliminates potential future migration of contaminants • Predicted times: completion ~ 15 years for clay-rich tills; <40 years for bedrock	• Does not address contaminated groundwater in carbonate bedrock • Significant system installation and operation costs (including a pilot study to determine effectiveness) • Construction and operation of treatment system that may require maintenance beyond typical design life • IDW generated during installation (approximately 15 drums each of liquid waste for beryllium and uranium -30 total drums). • Land use controls required until attainment of beneficial reuse status (until all ARARs are met)

Table 9.3. Time Frames for Alternative 7 - MNA and Alternative 8 - Active Pump and Treat at Luckey under Non-Pumping and Pumping Conditions

Constituent	Location	Alternative 7 Monitored Natural Attenuation			Alternative 8 Active Groundwater Treatment		
		Clay-Rich Till	Sand & Gravel	Bedrock	Clay-Rich Till	Sand & Gravel	Bedrock
NON-PUMPING CONDITIONS							
Beryllium	MW-01(I)	--	60	12	--	14	2
	MW-26(S)	--	150	40	--	50-80	25
	PW(W)[1]	--	0	3.5	--	0	1
Lead	MW-21(I)[2]	--	0	3.5	--	0	0.5
	MW-24(S)[3]	400-600	--	3.5	200-400	--	1
Uranium	MW-24(S)	>1,000	--	30	200-500	--	10
PUMPING CONDITIONS							
Beryllium	MW-01(I)	--	1.5	4.5	--	3.5	3
	MW-26(S)	--	175	40	--	90	26
	PW(W)[1]	--	0	1	--	0	1
Lead	MW-21(I)[2]	--	0	1.2	--	0	0.5
	MW-24(S)[3,4]	400-600	--	NA	200-400	--	NA
Uranium	MW-24(S) [4]	>1000	--	NA	200-500	--	NA

[1]—Simulations for beryllium at PW(W) were initiated with beryllium in the bedrock only, and concentrations never exceed ARAR-based cleanup goals in the sand and gravel.

[2]—Simulations for lead at MW-21(I) were initiated with lead in the upper weathered bedrock only, and concentration never exceed ARAR-based cleanup goals in the overlying sand and gravel.

[3]—Sand and gravel does not occur at MW-24(S) and therefore, no time frames are reported for both uranium and lead at this location.

[4]—Simulations for lead and uranium under pumping conditions were completed with the source term (starting concentrations) released in the overburden. No simulations were run with the source term released only in the upper bedrock, and therefore, time frames are not reported for the bedrock for lead and uranium at MW-24(S).

Note: The time frames in Table 9.3 are based upon predictive modeling results. Modeling was not performed for electrokinetics. Estimated total time for the completion of groundwater remediation using electrokinetics is 15 years for the clay-rich tills and the sands and gravels. Remediation of groundwater in the carbonate bedrock is assumed to be similar in duration to MNA for achievement of ARARs since electrokinetics may not be effective (< 40 years). Long time frames for achievement of ARARs are possible (as predicted from modeling) for groundwater in the clay-rich till. In particular, the area around MW-24(S) results in significant time frames for both MNA and pump and treat evaluations if constituents occur within the clay-rich till above the weathered bedrock. MW-24(S) is completed across the interface between the clay-rich till and the upper weathered bedrock. Based upon the lithologic log for MW-24(S), clay-rich till occur immediately above the bedrock (there is no significant sand and gravel identified in the log for MW-24(S)). Therefore, no time frames are reported in Table 9.3 for sand and gravel at MW-24(S) for either lead or uranium.

10.0 PREFERRED ALTERNATIVE

10.1 SOILS

USACE prefers Alternative 5, Excavation of Soils and Off-site Disposal (Soils) – Unrestricted Land Use, to address impacted soils. All soils, both on-site and those adjacent to the site, exceeding unrestricted land use cleanup goals will be excavated and shipped off site for disposal at a licensed/permitted disposal facility. Alternative 5 is considered to be the most protective both in the short and long term and is permanent because all soils exceeding the unrestricted land use cleanup goals will be removed from the Luckey site. This complete removal also precludes further potential for contamination of the groundwater system. Alternative 5 ensures compliance with the ARARs, since all of the materials exceeding the unrestricted land use cleanup goals are removed from the Luckey site. Cleanup goals will be used as target concentrations (e.g., 95% upper confidence limit of the mean) of the COCs that may remain. In addition, not to exceed concentrations will be developed to ensure no localized areas remain potentially posing unacceptable risk. MARSSIM will be applied for radionuclides.

Alternative 6, Excavation of Soils, Treatment, and Off-site Disposal (Soils) – Unrestricted Land Use, also is considered to be as protective in the long term as Alternative 5. It is, however, more costly and may not be as protective as Alternative 5 in the short term due to the potential for worker exposures and releases during the treatment operations. Alternative 6 does ensure compliance with the ARARs. Alternative 6 also is considered to be permanent, since all soils exceeding the unrestricted land use cleanup goals will be removed from the site. Both Alternative 5 and Alternative 6 involve the complete removal of impacted soils exceeding the unrestricted land use cleanup goals. Although treatment in Alternative 6 reduces the disposal volume, Alternative 6 is more costly, may be more difficult to implement, and may result in additional waste streams that will need to be managed.

Alternative 1 is not compliant with ARARs, and thus, is not consistent with the threshold criteria of CERCLA, which requires compliance with ARARs. Accordingly, Alternative 5 is preferred by USACE for the impacted soils at the Luckey site.

10.2 GROUNDWATER

USACE prefers Alternative 7, Monitored Natural Attenuation (Groundwater), for remediation of the groundwater at the Luckey site in conjunction with the remediation of the soils at the site using Alternative 5. Monitoring of the contaminated groundwater at the site over the past four years has shown that there is a general decline in the uranium and lead concentrations, thus suggesting that natural attenuation is occurring. However, the beryllium concentrations have not shown the same general declining trend. An assessment of the investigation results and past monitoring results suggest that the groundwater may be picking up beryllium contamination from the soils as the water table rises. With the source being removed, as discussed above, the beryllium concentrations are expected to naturally attenuate as well. Until the groundwater cleanup goals are met and verified, land use controls will be necessary to minimize the potential for any exposures. A Performance Monitoring Program will be conducted at the Luckey site to evaluate the remedy effectiveness and to ensure protection of human health and the environment. This monitoring program will be used to demonstrate that natural attenuation is occurring according to expectations, to determine if the existing contamination is expanding, to ensure no impact to down-gradient receptors, to detect new releases, to detect changes in environmental conditions that may impact the natural attenuation process, and to verify attainment of the cleanup objectives. This monitoring program will continue as long as the COCs remain above the required cleanup goals. If the Performance Monitoring Program demonstrates that there are changes to environmental conditions or that the attenuation process is not proceeding as expected within the first five to ten years, then decisions regarding what actions are necessary will be made at that time based on the data and information gathered from the monitoring program. Alternative 7 is the least costly of the groundwater alternatives and provides the same level of long-term protectiveness and permanence as the other alternatives. Alternative 7, as well as the two other alternatives (Alternative 8 and 9), is permanent and will meet the ARAR criteria because it will reduce the COCs to the cleanup objectives in a reasonable amount of time. Although Alternative 7 might require the longest period of time (40 to 150 years) to achieve the cleanup objectives, the performance period is reasonable when compared to the other two alternatives and the associated uncertainties associated with their implementation.

Alternative 8, Active Groundwater Treatment - Ex Situ (Groundwater), also is considered to be protective and permanent. Alternative 8 does meet the ARARs as discussed above because the COCs would be removed from the groundwater by a treatment facility until the cleanup objectives are achieved. This alternative is much more costly than Alternative 7, but is expected to decrease the time period for achieving the cleanup objectives by approximately one-half. However, there are uncertainties regarding the implementation and effectiveness of the technology, thus resulting in the potential for this alternative to take much longer to achieve the cleanup objectives. Also, there is some uncertainty associated with maintaining the treatment facilities for extended operational periods (e.g., >50 years). Unlike Alternative 7, Alternative 8 will involve an operating facility and the generation of other wastes that will need to be managed. This presents a slightly greater short-term risk to the public and environment associated with the management of the waste as well as the operation of the treatment facility.

Alternative 9, Electrokinetics (Groundwater), also is considered to be protective, and permanent. Alternative 9 meets the ARARs as discussed above because the COCs would be removed from the groundwater using a network of wells containing electrodes to treat groundwater. The electrodes will create an electrical field, driving the COCs to one set of wells for removal until the cleanup objectives are achieved. This alternative is much more costly than Alternative 7 but is expected to provide for the shortest time period for achieving cleanup objectives. However, there are uncertainties regarding the implementation of this relatively new technology and its effectiveness. This allows for the potential for this alternative to take much longer to achieve the cleanup objectives. Unlike Alternative 7, Alternative 9 will involve operating equipment, significant use of electrical energy, and the generation of other wastes that will need to be managed. This presents a slightly greater short-term risk to the public and environment associated with the management of the waste as well as the operation of the treatment facility and equipment.

Accordingly, Alternative 7 is preferred by USACE when implemented with the preferred soils remediation alternative discussed above for soils.

10.3 CONCLUSION

USACE expects the Preferred Alternatives, for both the soils and groundwater, to satisfy the following statutory requirements of CERCLA §121(b): (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost-effective; and (4) utilize permanent solutions that will preclude any future environmental impact to the environment or the groundwater system. Implementation of both the soil and groundwater alternatives together will allow release of the site for unrestricted use in a reasonable period of time. Release of the Luckey site would only be with respect to the AEC-related materials associated with the beryllium production process.

11.0 COMMUNITY ROLE IN SELECTION PROCESS

Public input is encouraged by USACE and no final decision will be made on a remedy until all comments are considered.

The Administrative Record contains all documentation used to support the preferred remedy, and is available at the following locations:

USACE FUSRAP Public Information Center
1776 Niagara Street
Buffalo, NY 14027
(716) 879-4197
(800) 833-6390 and press “5” at the recorded message.

Luckey Public Library
228 Main Street
Luckey, OH 43443
(419) 833-6040

The public is encouraged to review and comment on all alternatives described in this Proposed Plan and the supporting Feasibility Study and Remediation Investigation.

Comments on the proposed remedial action at the Luckey site will be accepted for 30 days following issuance of this Proposed Plan in accordance with CERCLA, as amended, and the NCP. A public meeting will be held during the comment period to receive any verbal comments the public wishes to make. Written comments the public wishes to submit regarding the preferred remedy will be received at the meeting or during the 30-day period. Responses to the public comments will be presented in a response to comments in the ROD, which will document the final remedy selected for the Luckey site.

All written comments should be addressed to:

U.S. Army Corps of Engineers, Buffalo District
FUSRAP Public Information Center
1776 Niagara Street
Buffalo, NY 14207-3199

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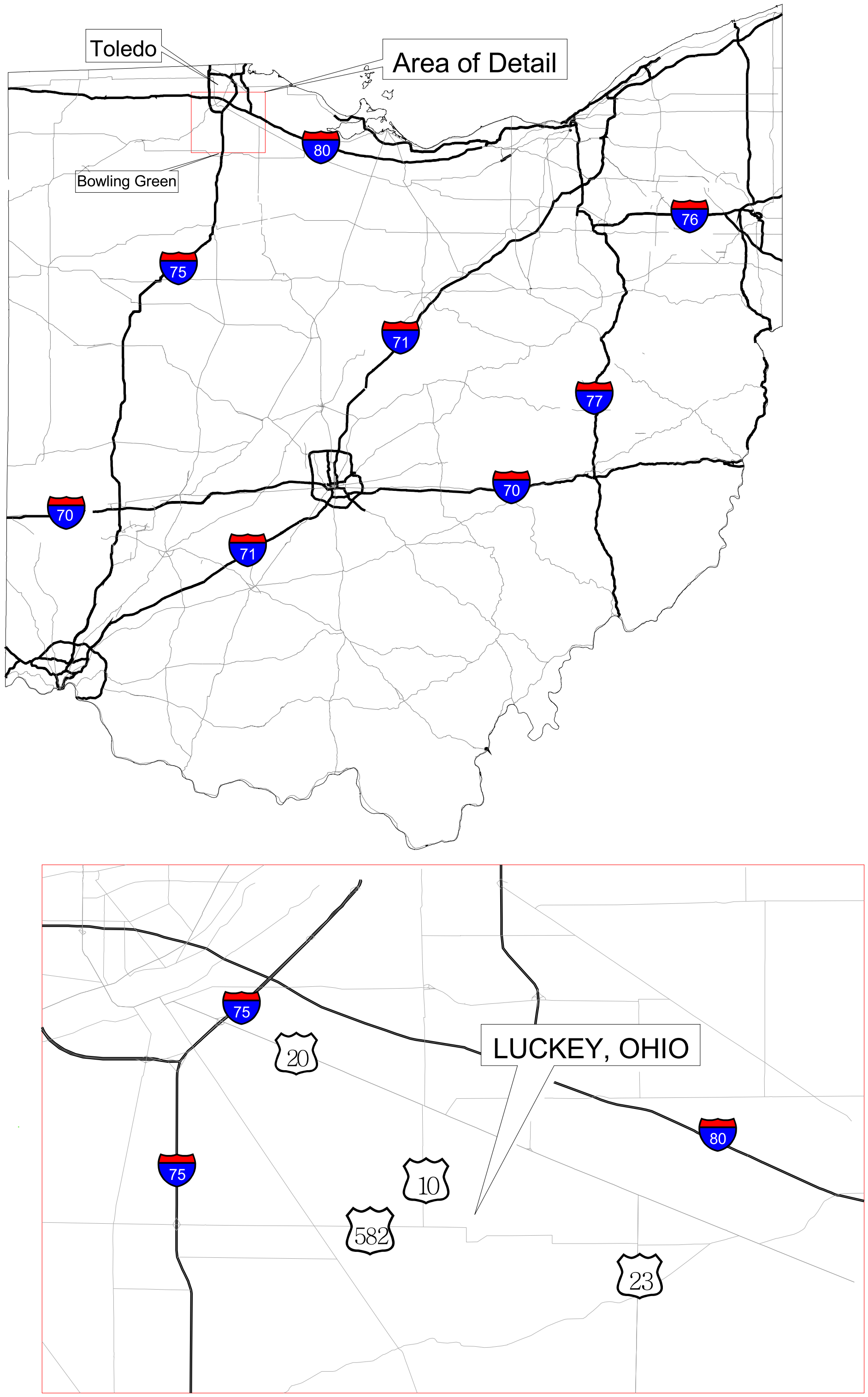

Primary road with limited access
Primary road

60 0 60 Miles

N
W E
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S:ARCVIEW LUCKEY/C01748/801/SITE LOCATION FS Report Fig No. 2.1

U.S. Army Corps of Engineers
Buffalo District

LUCKEY SITE

Site Location

SAIC Science Applications International Corporation Columbus, Ohio

Drawn By	Date	Scale	Project No.	Figure No.
LMA	04-02-01	As Shown	04-1612-533	2.1

N
W E
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0.05 0 0.05 0.1 Miles

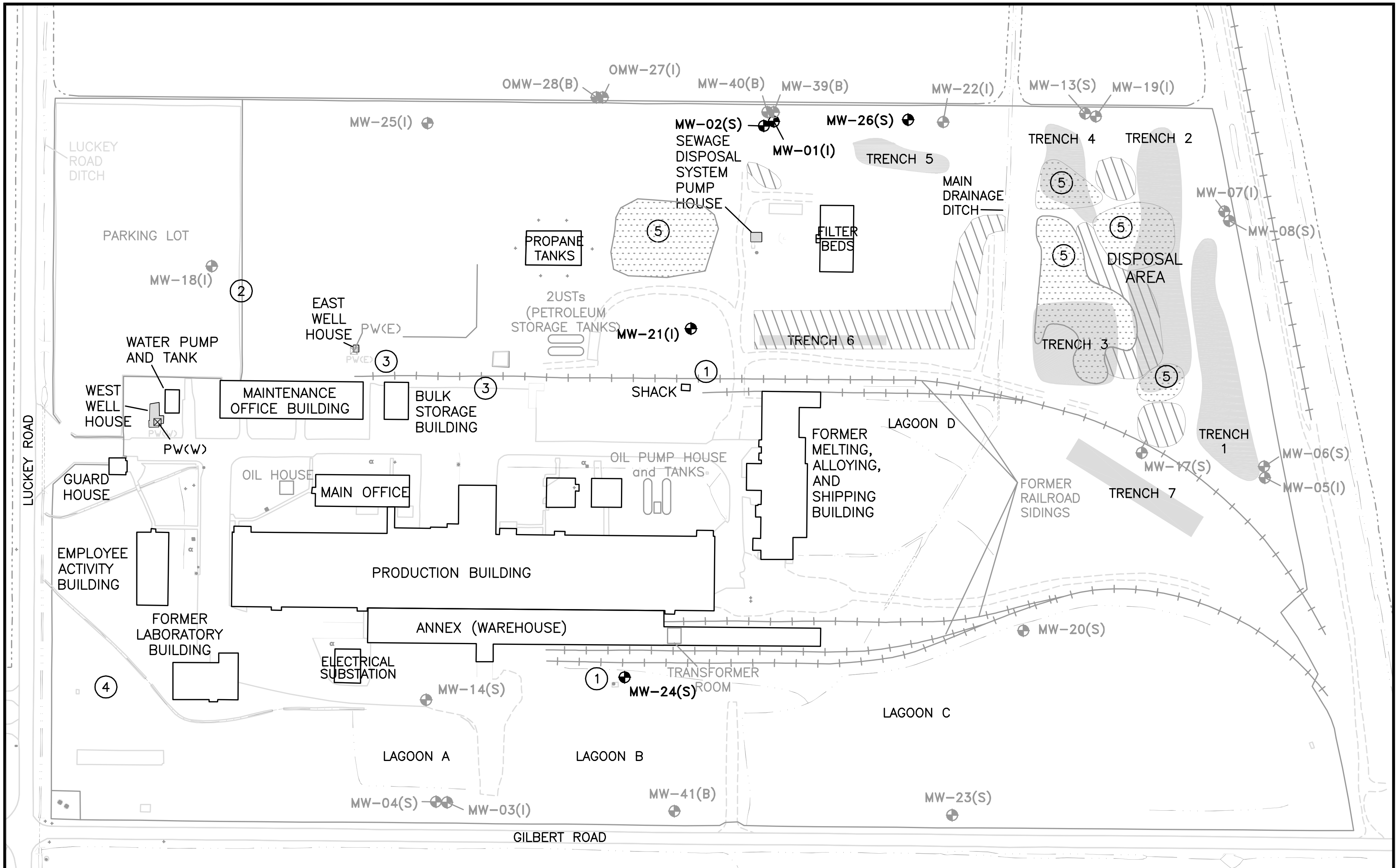
U.S. ARMY CORPS OF ENGINEERS
BUFFALO DISTRICT
LUCKEY SITE

Luckey Site near Luckey, Ohio

SAIC. ***Science Applications International Corporation*** Columbus, Ohio

DRAWN BY	DATE	Scale	PROJECT NO.	Figure NO.
LMA	04/02/02	As Shown	04-1612-533	2.2

S:ARCVIEW LUCKEY/GIS/PROJECT3.APR LAYOUT AERIAL PHOTO



	BUILDING		ABANDONED RAILROAD GRADE
	TRENCH	1	FORMER ORE STAGING AREA
	SPOILS PILES	2	FORMER LIME PIT
	MONITORING WELL	3	FORMER SCRAP STEEL STORAGE SITES
	PRODUCTION WELL	4	FORMER ENGINEERING BLDG. CISTERN
	FENCE LINE	5	AREAS DEVOID OF VEGETATION
	STREAMS & CREEKS		

N True North

100 0 100 200
FEET

31 0 31 62
METERS

U.S. Army Corps of Engineers
Buffalo District

LUCKEY SITE
PROPOSED PLAN

Features at the Luckey Site

SAIC. Science Applications International Corporation Columbus, Ohio

DRAWN	DATE	SCALE	PROJECT NO.	FIGURE NO.
BJW	03-19-01	AS SHOWN	08-1724-003	2.3

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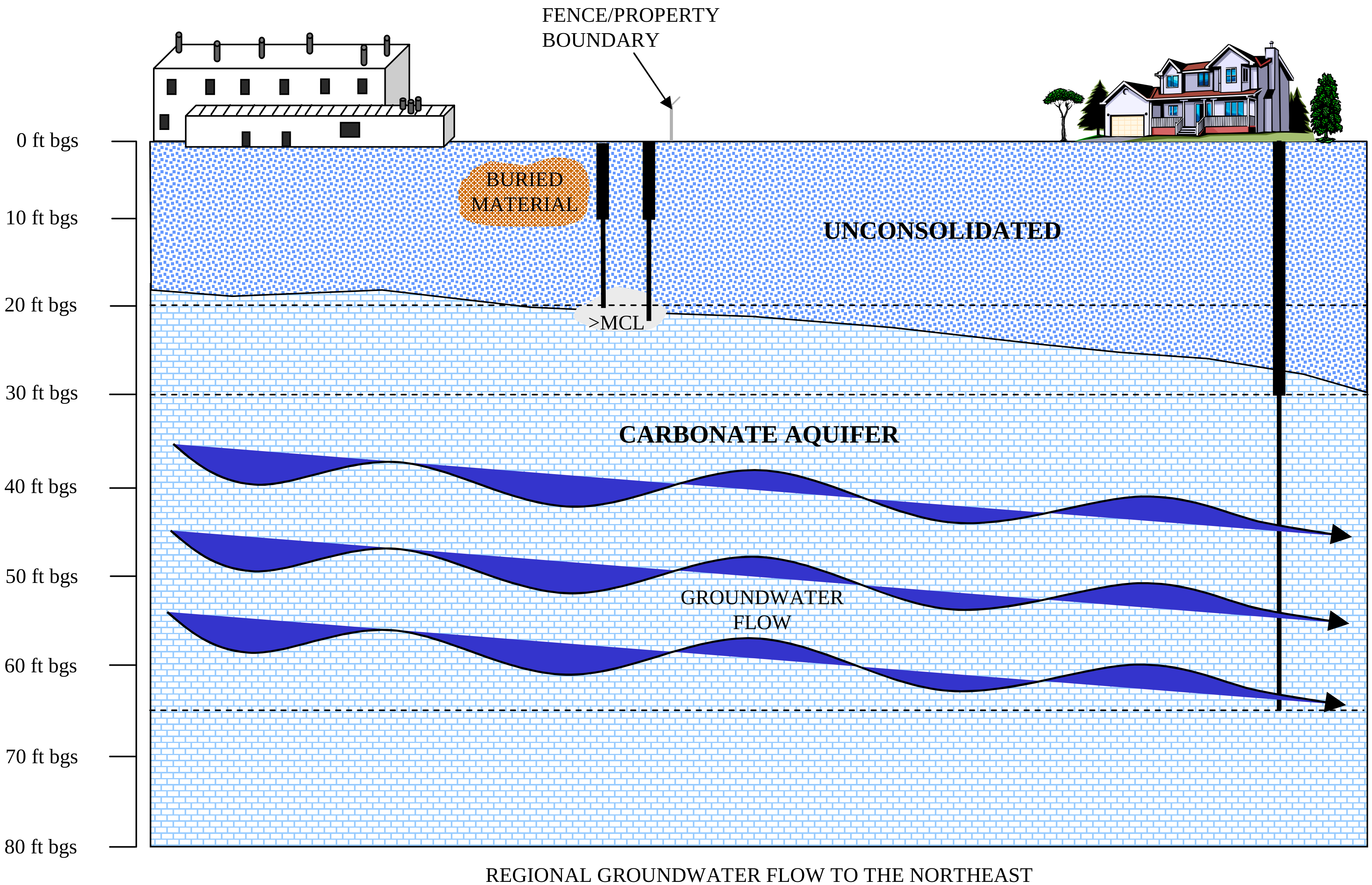


Figure 3.1 Conceptual Model of Groundwater

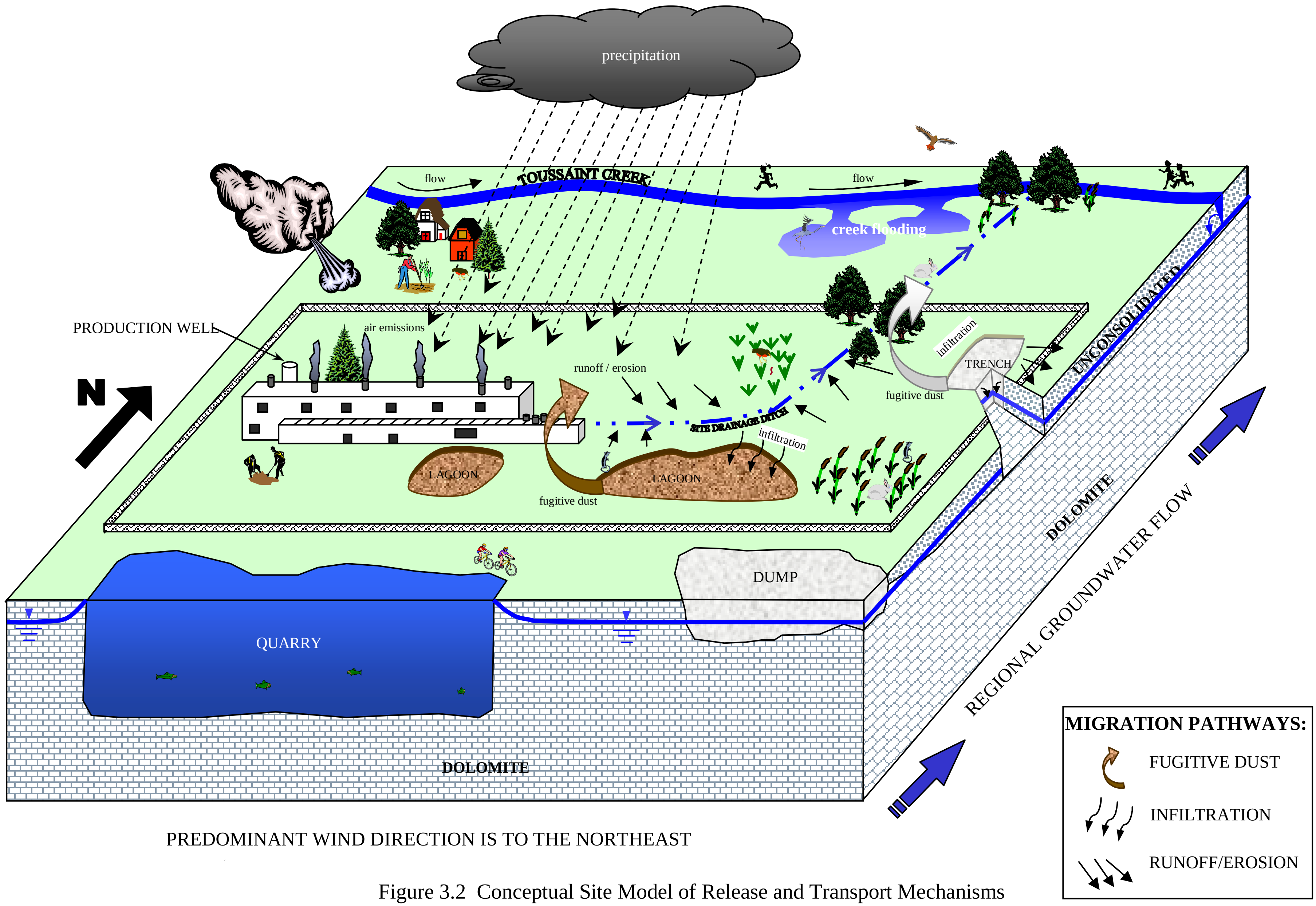
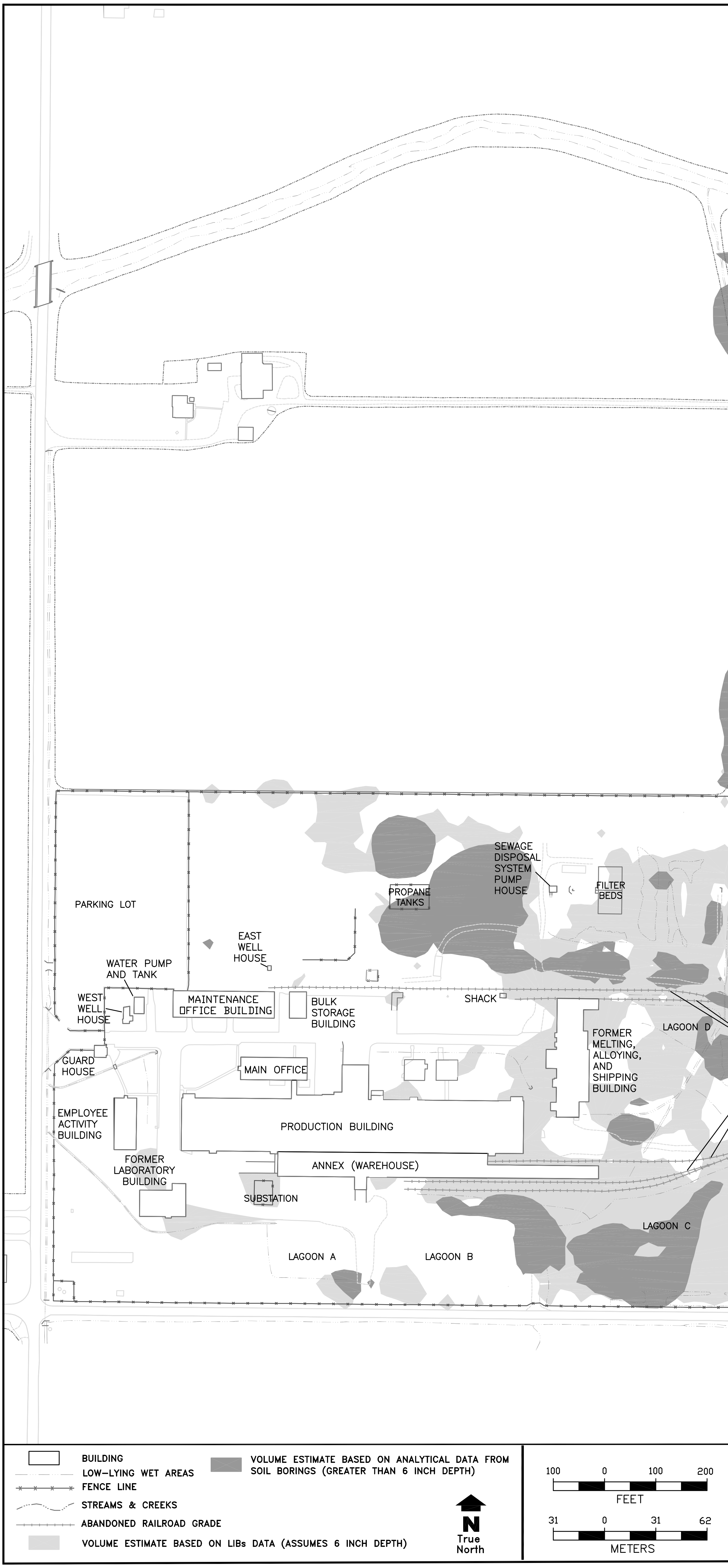


Figure 3.2 Conceptual Site Model of Release and Transport Mechanisms



U.S. Army Corps of Engineers
Buffalo District

LUCKEY SITE
PROPOSED PLAN

Extent of Impacted Soils
Unrestricted Land Use

SAIC Science Applications International Corporation Columbus, Ohio

DRAWN	DATE	SCALE	PROJECT NO.	FIGURE NO.
BJW	03-19-01	AS SHOWN	08-1724-003	3.3

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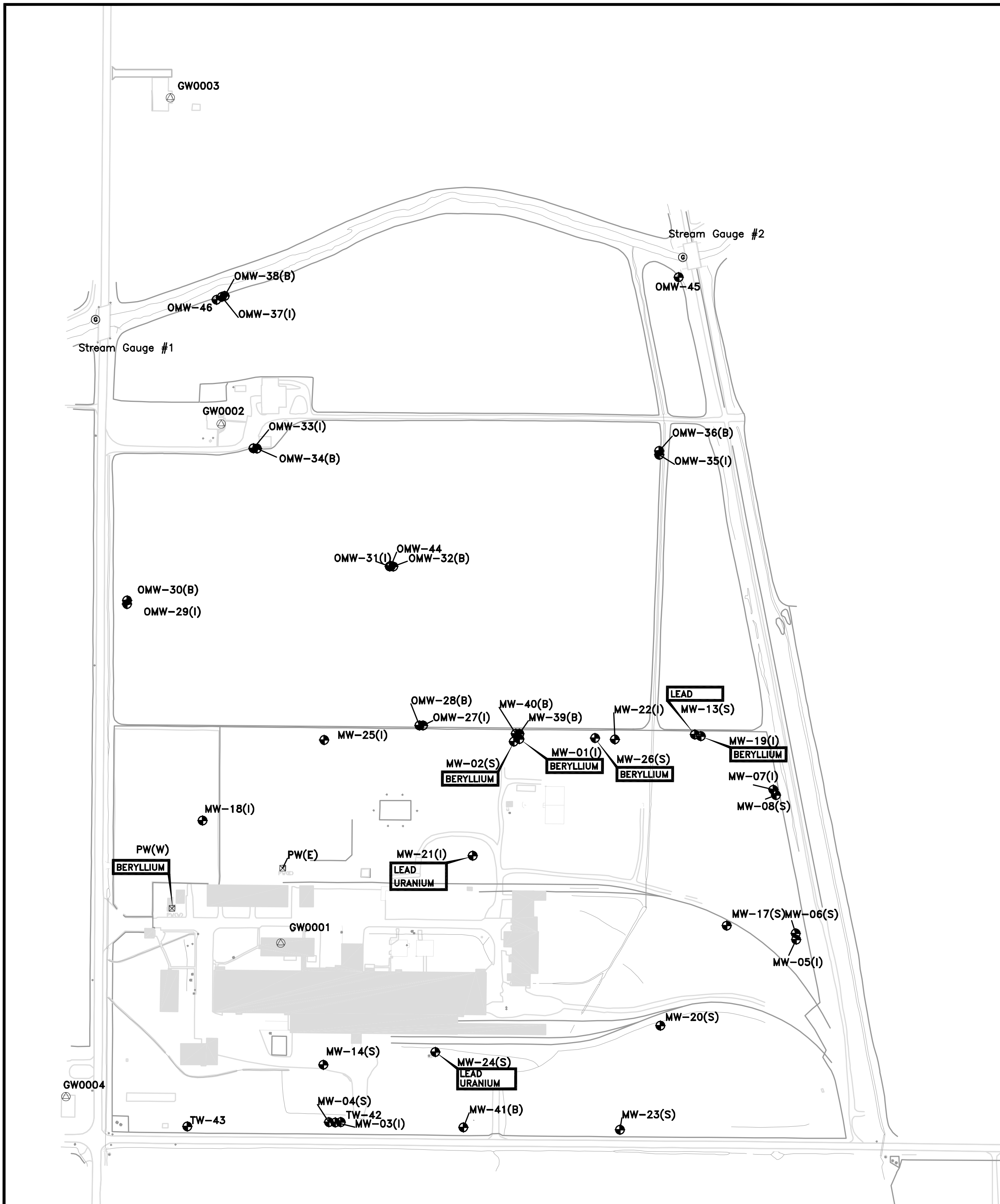

BUILDING
LOW LYING AREAS
FENCE LINE
STREAMS & CREEKS
ABANDONED RAILROAD GRADE
BERYLLIUM WELL CONTAINS ELEVATED BERYLLIUM
LEAD WELL CONTAINS ELEVATED LEAD
URANIUM WELL CONTAINS ELEVATED URANIUM
RESIDENTIAL WELLS/TAP WATER
GROUNDWATER MONITORING WELLS
G STREAM GAUGE

N True North

0 175 350
FEET
0 53 106
METERS

U.S. Army Corps of Engineers
Buffalo District

LUCKEY SITE
PROPOSED PLAN

Monitoring Wells with Beryllium, Lead, and Uranium Detected above Cleanup Goals

SAIC Science Applications International Corporation Columbus, Ohio

DRAWN	DATE	SCALE	PROJECT NO.	FIGURE NO.
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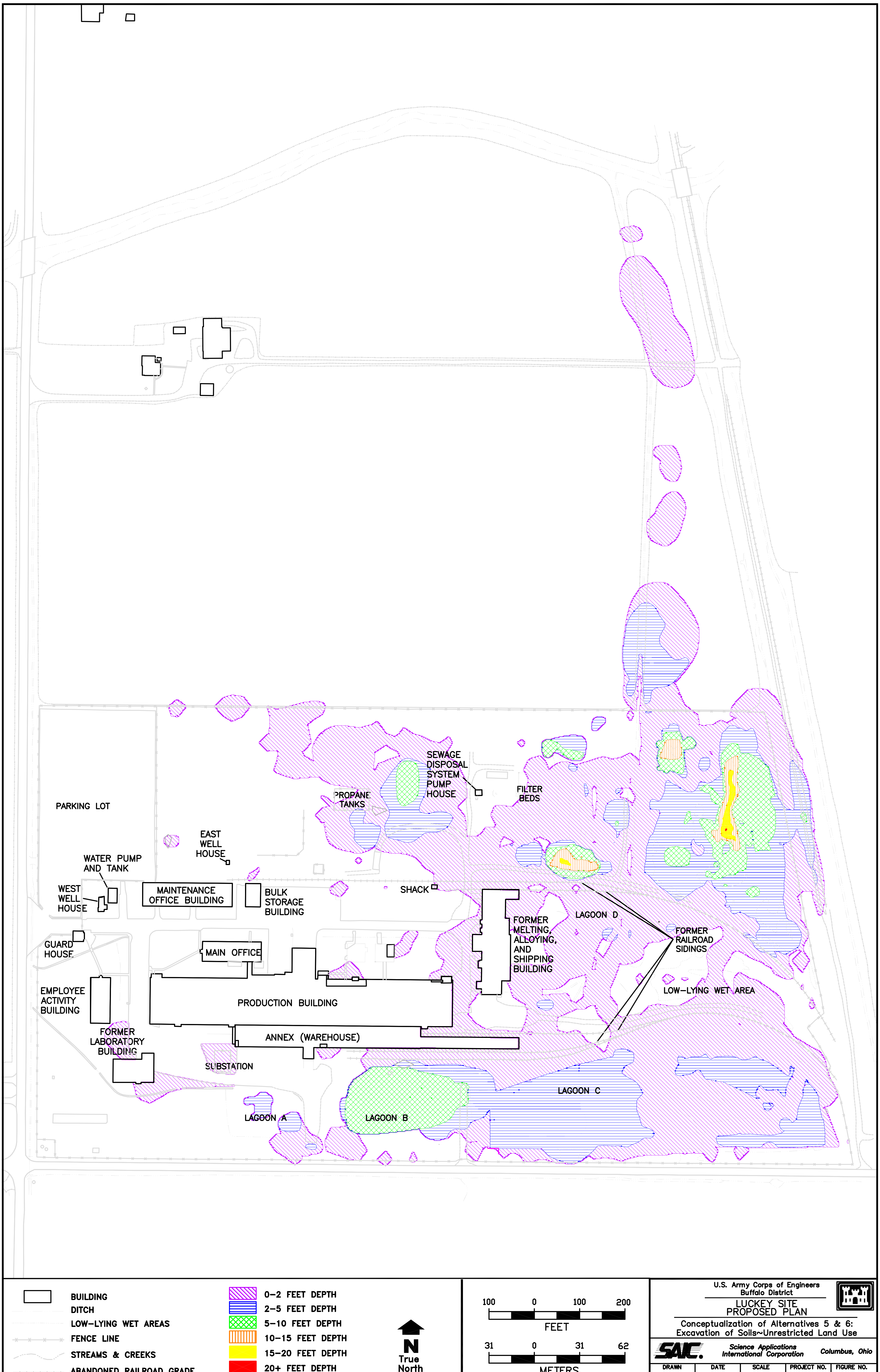

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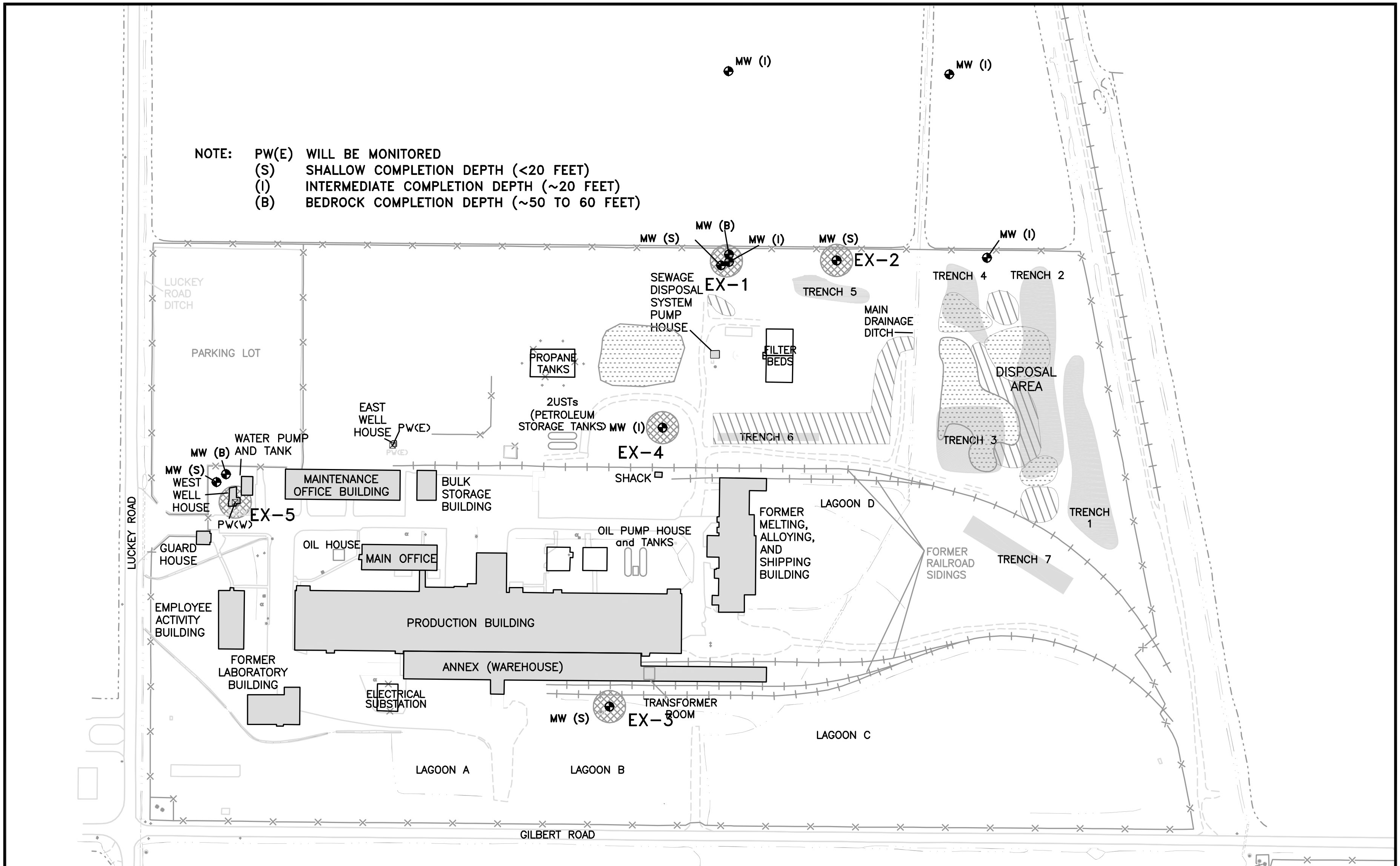

BUILDING
TRENCH
SPOILS PILES
MONITORING WELL
PRODUCTION WELL
FENCE LINE
STREAMS & CREEKS
ABANDONED RAILROAD GRADE
AREAS DEVOID OF VEGETATION
DENOTES AREA FOR PLACEMENT OF EXTRACTION WELLS
EX-3

N
True North

125 0 125 250
FEET
38 0 38 76
METERS

U.S. Army Corps of Engineers
Buffalo District

LUCKEY SITE
PROPOSED PLAN

Conceptualization of Alternatives 7 & 8:
MNA & Active Groundwater Treatment

SAIC. Science Applications International Corporation Columbus, Ohio

DRAWN	DATE	SCALE	PROJECT NO.	FIGURE NO.
BJW	03-19-01	AS SHOWN	08-1724-203	7.2

XREF Files: LUCKFEET DRIVES FENCE FIELDS IABOUNDS IAINFO MISC ROADS RR-RAIL STRUCT TOPO TREES UTILSTRC WATER IMAGE Files: Armylogoblk.bmp feet.tif 2

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